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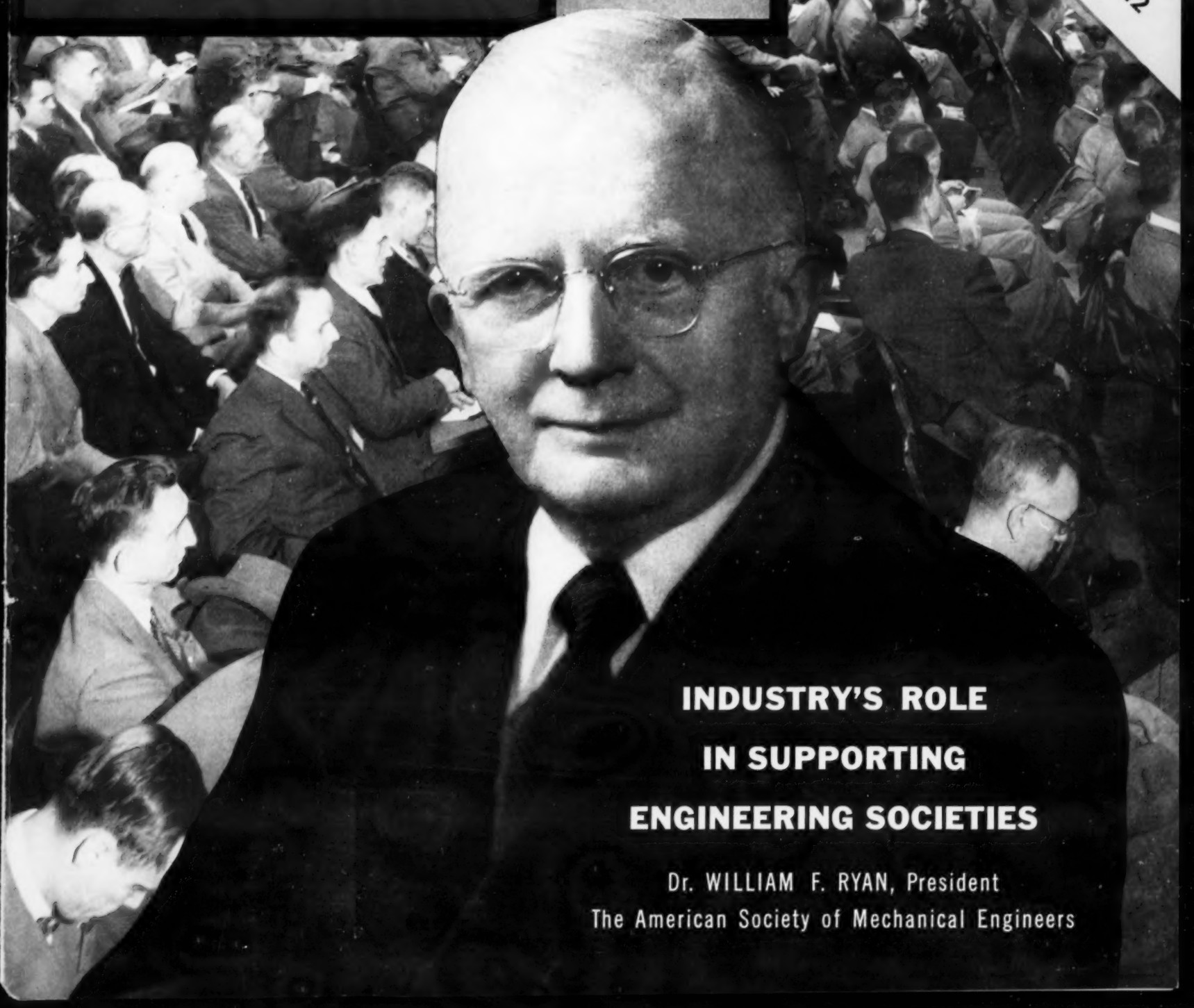
Power Industry

A Putman Publication | "Executive Magazines for Industry"

OCTOBER 1957

For the Power Services Management Team

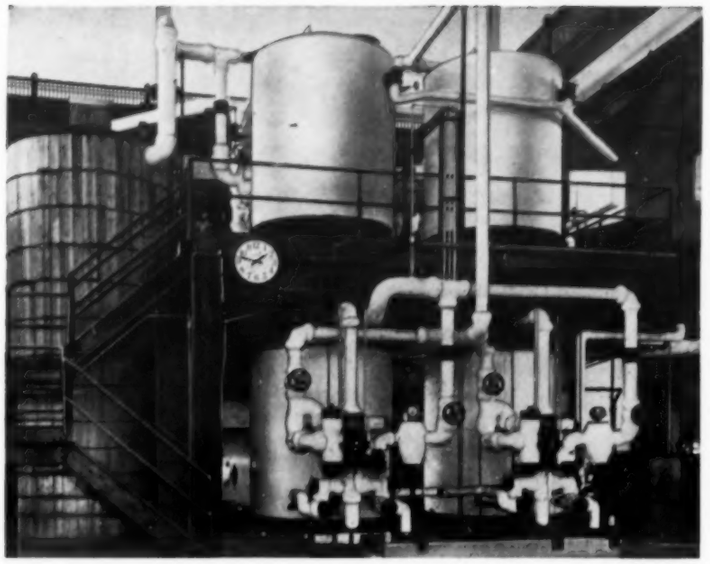
What Engineers Think of Their Profession
A Power Industry Survey . . . Page 12



INDUSTRY'S ROLE IN SUPPORTING ENGINEERING SOCIETIES

Dr. WILLIAM F. RYAN, President
The American Society of Mechanical Engineers

Your boiler feedwater problem is different!



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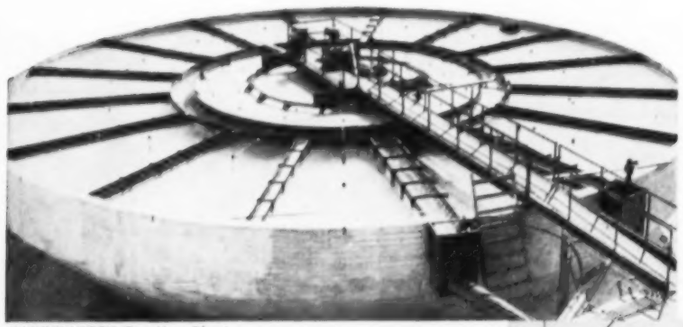
That is why INFILCO offers you a complete range of water treating plants custom engineered to meet your particular requirements. For example—

If you use high pressure boilers, you might require a CATEXER® ANEXER® Demineralization Plant. These plants give you improved make-up quality, adequate supply regardless of station electrical load, reduced overall operating costs, and lowered maintenance costs and labor expense.

For low pressure boilers, the ACCELATOR® Treating Plant offers a most economical means of treating feedwater. It is also frequently recommended for pre-treating make-up water for high pressure boilers. "ACCELATOR" Clarifiers and Softeners have a proven record of flexibility and ease of operation.

Feedwater for intermediate boiler pressures can often be treated by INFILCO Hot Process Softeners. These softeners are noted for their accurate treatment control and superior performance. They are often used in combination with Hot Process Zeolite Softeners.



"ACCELATOR" Treating Plant

Whatever your feedwater problem, you can depend on the complete engineering know-how and many years experience that have made INFILCO a leader in this field. Why not submit your problem today. INFILCO engineers will suggest a practical solution. Write for information.

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THE ONE COMPANY offering equipment for ALL types of water and waste treatment — coagulation, precipitation, sedimentation, filtration, flotation, aeration, ion exchange and biological processes.

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Power Industry

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Industrial Power and Industry Power

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will be found on page 51

The power services include the production, transmission, and application of all forms, of energy—steam, electricity, mechanical power, pneumatic, hydraulic—and engineering maintenance for the power services in the following:

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A PUTMAN PUBLICATION

Power Industry

FOR THE POWER SERVICES MANAGEMENT TEAM

VOLUME 73 NO. 5 OCTOBER 1957

industry's role in supporting engineering societies 11
ASME president William F. Ryan asks: "Why aren't young engineers attending engineering society meetings?".

POWER INDUSTRY's engineering shortage survey 12
Is there an engineering shortage? Are engineers underpaid – are their skills misused? Here are your answers.

better part-winding starting 14
Improved, low-cost switching method starts heavy polyphase motors quickly without causing overload on power supply.

it wasn't the pumps but the piping 16
Flashing and water hammer puzzle Union Carbide's engineers – detective work reveals the real troublespot.

protecting a 30-inch pipe 16
Leaks in main header line from pumphouse threatens shutdown of Diamond Alkali Co. plant. Cathodic protection stops leaks – permanently.

eliminate power house window maintenance 18
General Electric Co. solves problems of glare, weather protection by installing insulated metal panel curtains in its turbine room.

pipeline overcoat saves heat 18
Esso Standard Oil Co. saves $500,000 by installing insulating overcoat on exchange pipeline carrying steam and fuel oil.

what you need in power plant records 18
Good power plant record system is vital for intelligent operation and maintenance. Grade your system against this one.

coal for the digging 21
Hydraulic dredge recovers over 1 million tons per year of coal-bearing silt and mud from bottom of the Susquehanna River.

spot fire protection pays out in four months 21
Five Scripto Inc. plants in Atlanta save three times the cost of their fire-protection systems in lower insurance payments.

filter scrubs itself 22
California Electric Power Co. cleans water from irrigation canals with a low-cost method that reduces solids content below 5 ppm.

electric membrane demineralization 22
Low-cost electric demineralizing system by Ionics, Inc. gives 9000 gpd of potable water for Air Control and Warning Station.

power basics for today's industry—fluid mechanics 24
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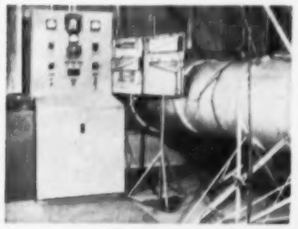

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for observing and recording operating characteristics of fans being tested in chamber shown at top.

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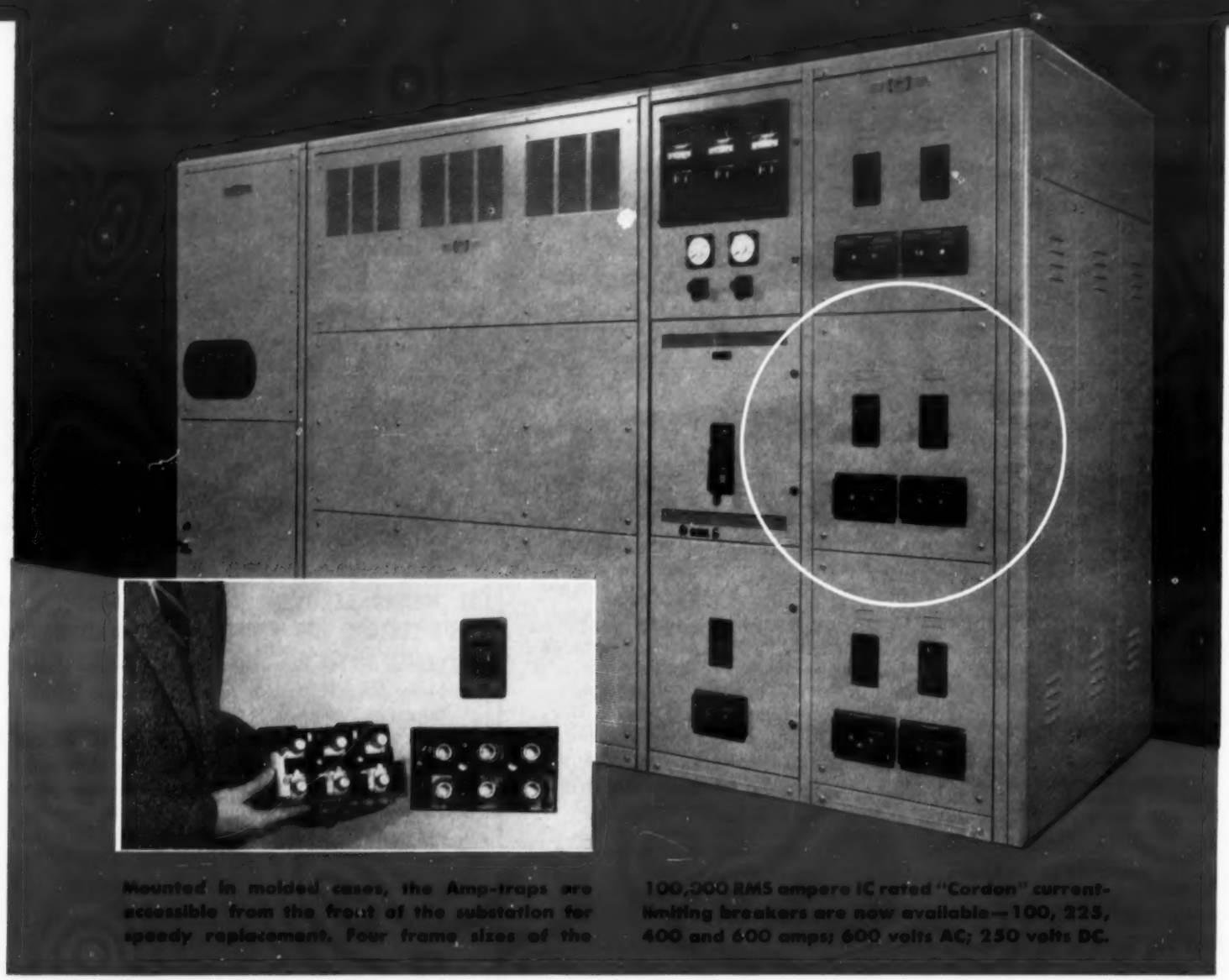

Mounted in molded cases, the Amp-traps are accessible from the front of the substation for speedy replacement. Four frame sizes of the 100,000 RMS ampere IC rated "Cordon" current-limiting breakers are now available—100, 225, 400 and 600 amps; 600 volts AC; 250 volts DC.

BullDog Unit Substations provide greater protection against high short circuits with new "Cordon" current-limiting breakers

Protect your equipment! Fault currents of 100,000 RMS amperes can destroy equipment by arcing, burning and magnetic distortion. The new BullDog unit substation with "Cordon"* breakers provides this necessary protection.

"Cordon" breakers bring real savings, too, since they can be used where more costly air breakers were once required. They combine the advantages of standard thermal magnetic breakers with current limiting characteristics of Amp-traps** . . . limit damaging fault currents to low values.

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PI news

Ship St. Lawrence power project transformers

First of the thirteen 115/230 kv, 86,000-kva Brown Boveri single-phase power transformers

are loaded on flat car (above) for shipment to St. Lawrence Power Project, Power Authority, State of New York. Transformers incorporate radial core design, resulting in more compact, lightweight transformers, using minimum of oil. Transformers are cooled by external oil-to-water heat exchangers.

Electric power supplanting steam in oil industry

General trend for power requirements in oil refining industry is "toward use of an increasing proportion of electric motors as compared to steam turbines," Lee B. Eddy, Universal Oil Products Co., tells AIEE Conference of the Petroleum Industry. Power requirements of oil refining processes have increased significantly in recent years, says Eddy, and "as electric generating capacity and distribution system reliability increase, electric motors will take over an even larger portion of the muscle work in refineries."

FROM THE MAILBAG . . .

Operation Alert

"Your article on 'Operation Alert' – action at Oklahoma Gas & Electric Co.'s power plants – was quite interesting. Is the headquarters at some remote rural area away from probable damage area? I raise this question because you note: 'Key point in the disaster set-up is the Dispatcher's office, located in downtown Oklahoma City."

MOGUL-IZING...as modern as the famous UNIVAC® SYSTEMS

Photograph courtesy of Remington Rand Univac

Remington Rand Univac, Division of Sperry Rand Corporation, recently completed the above pictured multi-million dollar plant at Univac Park, St. Paul, Minnesota. To help protect this major investment, MOGUL water treatment products were selected.

Remington Rand has joined the growing list of many of the world's largest corporations that have MOGUL-IZED with Mogul Quality Products and Mogul Service.

MOGUL-IZING offers a completely integrated water treatment program — with performance results "guaranteed" and backed by a bond.

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The North American MOGUL Products Company

Standard Building • Cleveland 13, Ohio

SPECIALISTS IN INDUSTRIAL WATER TREATMENT FOR OVER 40 YEARS

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PI news . . . starts on page 5

Then further along: 'an H-bomb, size estimated to be 5 megetons, has exploded at ground level on Oklahoma City . . . departments report to the emergency center . . . these people converge on headquarters.' It is apparent that the headquarters would be destroyed, and therefore no point in people converging there, even if it could be reached. Don't key people move on the 'yellow alert'? We have our several emergency centers located outside Philadelphia. Key persons move out to these relocation centers on the 'yellow alert' relayed from the Bell and Light warning received at the several dispatch centers."

Mr. K. M. Irwin,
Vice President,
Philadelphia Electric Co.
Acting Power Director,
DEPA Area No. 3.

Even as in Philadelphia, OG&E has an alternate Dispatcher's Office located in a rural area. For the purposes of the CD Alert that POWER INDUSTRY *covered, however, the downtown Oklahoma City headquarters was used.*

Paging Dr. Liebknecht

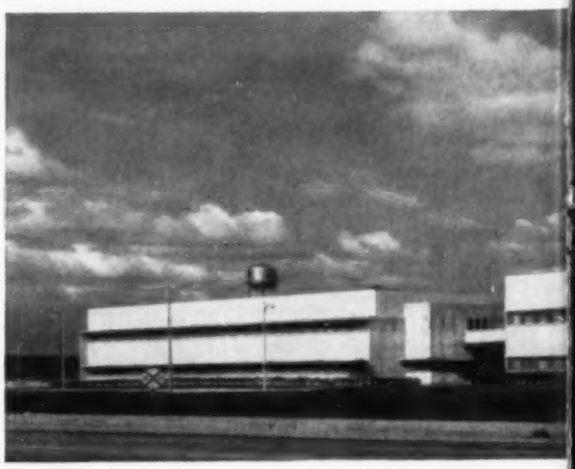
"Please let me know how serious your New South Wales reporter was in submitting the article on page 25 of the August 1957 issue of your magazine. I cannot help feeling that Dr. A. Liebknecht's research may be as erratic as is the continuity of his prose and as colorful as his career. In your next issue could you include a diagram of a 'parametric boloid slot?' I certainly enjoyed the Doctor's article. May he publish many more in a similar vein."

W. R. Laidig,
Port Edwards, Wis.

Let Reader Laidig read the letter below for more errata on Dr. Liebknecht, plus a diagram of the now-famous parametric boloid slot.

"Your request for further graphic material covering the article by my honored colleague, Dr. A. Leibknecht, in your esteemed publication should be

Pneumatic Control System Adds to Plant Efficiency at A·B·DICK COMPANY...



Accurate control of temperatures and humidities is required throughout the 715,000 sq. ft. plant of A. B. Dick Company, the nation's largest exclusive maker of duplicating equipment and supplies. The multi-building plant has a wide variety of control needs, all of which are met by a specially engineered Johnson Pneumatic Control System.

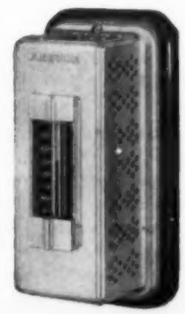
In the air conditioned web process section, for example, stencils wrinkle if humidity is too high, won't coat properly if too low. Extremes of heat, cold and humidity as well as constant temperature and humidity conditions are produced in connection with the company's extensive research and testing programs. In the general manufacturing and assembly area, the system operates 47 ceiling-mounted heating and ventilating units. The explosion-proof features of pneumatic control are essential in areas where ether, alcohol and other hazardous materials are used. And, of course, there's the provision of air conditioned comfort for the administrative, sales and technical staffs.

This close control of temperatures and humidities simplifies A. B. Dick Company's material handling and processing problems, helps assure high speed, quality production and improves worker efficiency.

Let Johnson help you enjoy similar benefits. Johnson Pneumatic Control Systems offer a combination of advantages unmatched by any other method of control . . . widest flexibility, high accuracy, fewer components and easier, less costly operation. A nearby Johnson engineer has all the facts. Johnson Service Company, Milwaukee 1, Wisconsin.

JOHNSON CONTROL
PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885



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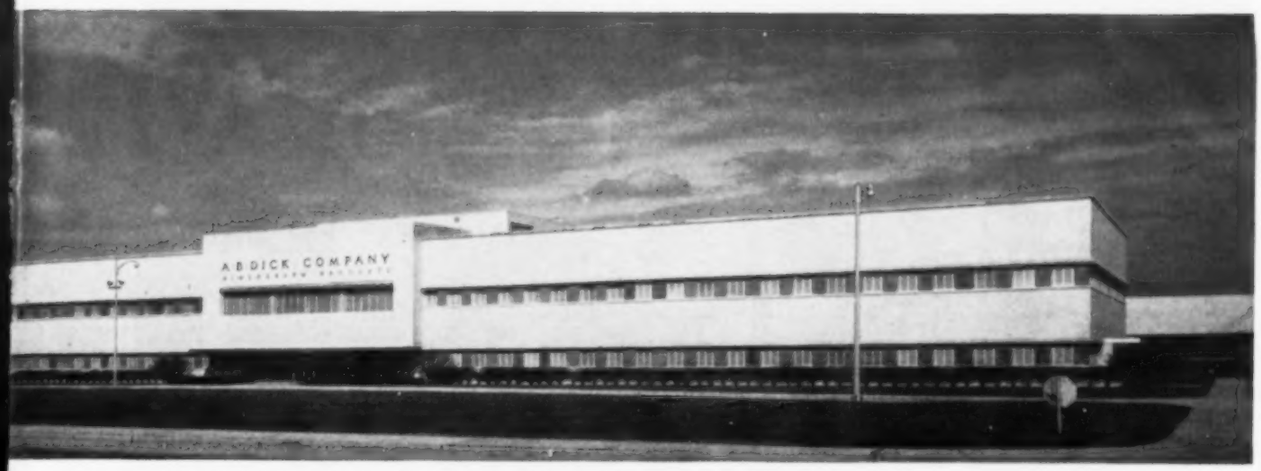
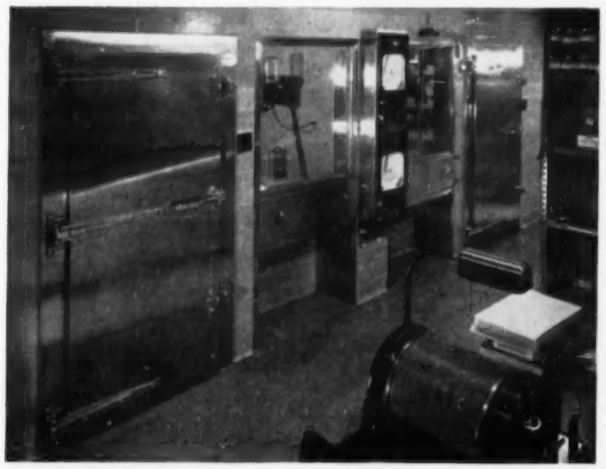


A. B. Dick Company, Chicago. Main Office and Plant designed and built by The Austin Company. For the West Office Building, Ragnar Benson, Inc., Chicago, engineers and builders, and Robert E. Hattis, Chicago, consulting engineer.

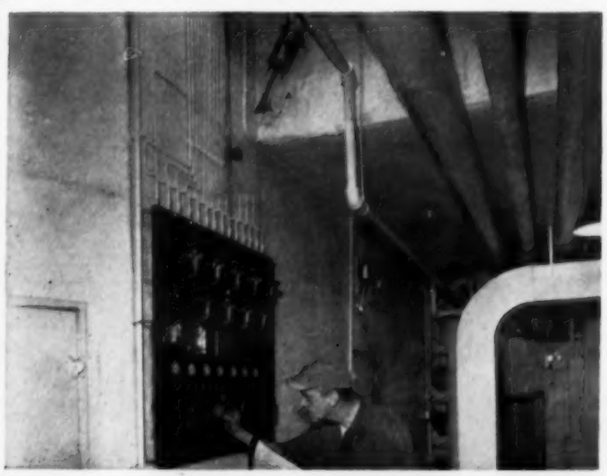


In the main test section, A. B. Dick products are subjected to continuous, exhaustive tests. The Johnson System maintains a constant condition of 72 F and 50 per cent relative humidity. In the isolated dry room, left, and hot-humid room, right, special tests are conducted under extremely adverse conditions. In this section, temperature variations are limited to ± ½ F and humidity to ± 2 per cent.

Equally close control is maintained in the chemical research laboratory where chemists and technicians work to develop new and better inks and paper coatings for use with A. B. Dick duplicating equipment. Comfortably air conditioned buildings such as this are a big asset in attracting high grade personnel and reducing employee turnover rates.

As with every progressive manufacturer, the development of new products never ceases. Below is a section of the A. B. Dick Company model shop in which new products are hand-made for testing under varied operational conditions. Here, as in many other areas of the building, there is complete year 'round air conditioned comfort.

Behind the scenes, Johnson controllers operate the central fan systems serving the many air conditioned zones of the building. Process hot water, perimeter radiation, process refrigeration and process condensing water are also Johnson controlled. Pressure gauges, exclusive with pneumatic systems, simplify operation.



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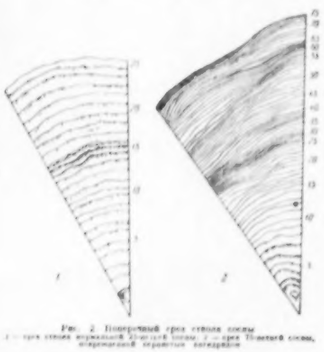
adequately covered by the enclosed diagram and chart. As you may see, the application possibilities of the parametric boloid slot have been explored by other nations to some extent. The enclosed diagram (see drawing below) from the procedings of the Latvian Academy of Fremodorpic Sciences of June 1937, is one of the clearest available as it illustrates in part (2) of the chart what may result if Inge's periodic peltering coefficient is ignored at higher speeds. The buildup is obvious. . . . . Dr. Liebknecht is up in Goondiwindi observing an outbreak of induced ionic wumperfication in feedwater that has had plant owners in that area baffled for several months now. We trust that the enclosed information is adequate."

Dro Redaxela
Assistant Director of
Research
Department of
Fremodorpic Research
University of Bathhurst



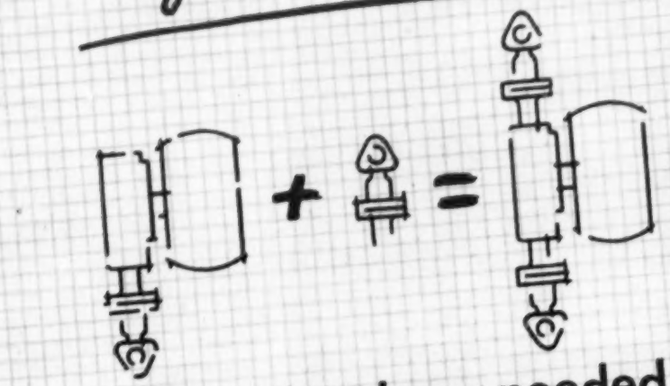
If any more interesting articles by the good Dr. Liebknecht turn up, the Editors of POWER INDUSTRY *will be most happy to print them.*

New "atom" dictionary is published by ASME

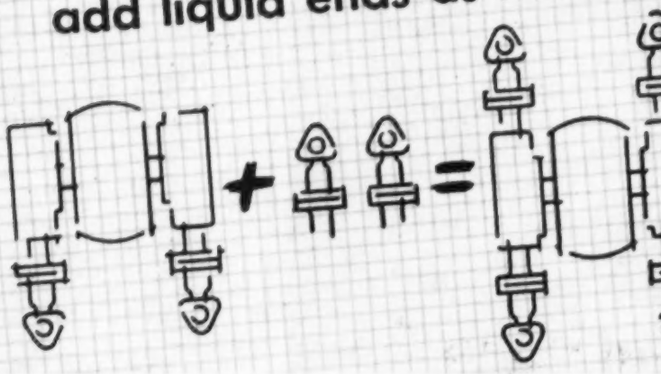
For the first time, scientists and others interested in atomic energy will have a standard "dictionary" to establish precise meanings for hundreds of technical terms used in the nuclear field. American Standards Association and ASME announce approval of the 180-page volume titled "Glossary of Terms in Nuclear Science and Technology," with ASME as publisher.

Book is designed to provide common language among medi-

advanced design in high pressure pumps



add liquid ends as needed



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FRAMES of Philadelphia High Pressure Pumps are designed for ease in compounding any simplex or duplex pump. Multiple units avoid large piston areas vs. high pressure. Obtain high capacities with reduced horsepower requirements.

RUGGEDNESS, ample proportions and sound mechanical and hydraulic engineering permit these pumps to take high pressures in their stride—to stand up in hard industrial service with a minimum of maintenance and down time.

WIDE CAPACITY RANGE—Pump selection charts (Catalog HP-1254) show range from minimum of 30 cc per hour (smallest simplex) to maximum of 1648 g.p.h. (largest quadruplex). Write for your copy of this catalog.

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PHILADELPHIA SERIES HP HIGH PRESSURE PUMPS

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P/I news

. . . starts on page 5

cal men, engineers, chemists, physicists, biologists and others working with the atom.

Appointments, transfers, kudos . . . in power industry

Dr. Thomas H. Johnson, former AEC research director, is appointed manager of research division, Raytheon Manufacturing Co., effective October 1.

Thomas Y. Mullen

Thomas Y. Mullen (above) joins Burns and Roe, Inc., as chief mechanical engineer for power projects. Martin A. Mayers, now chief mechanical engineer for all projects, is assigned to special projects. Mr. Mullen is a registered PE in New York, New Jersey, Pennsylvania, Maryland, Arizona and West Virginia, belongs to ASME.

Brinkerhoff Fink

J. E. Brinkerhoff (above, left) vice president, Babcock & Wilcox Co., is named president of The Refractories Institute at a board of directors' meeting of the trade association group.

Succeeding C. G. Grabe, National Valve and Manufacturing Co.'s vice president of engineering, who retires after 30 years, is R. W. Fink (right photo) former assistant chief engineer, who now becomes Navco's chief engineer. Mr. Fink is well known for his work on power piping systems, is currently working on an American Standards sub-committee to revise code for pressure piping.

Manager of heat transfer apparatus department, steam division, Westinghouse Electric Corp., is new assignment of David C. Fulton, former manager, marine section sales department. Mr. Fulton is a member of AIEE, Society of Naval Architects and Marine Engineers, and Institute of Aeronautical Sciences.

Highest honor that ASME can bestow will be given to E. G. Bailey, former president, to be made an honorary member.

Recipient of the Franklin Institute's Edward Longstreth Medal will be Dr. John Bertrand Johnson, head of the physics department, Edison Laboratory, McGraw-Edison Co., West Orange, N. J. Dr. Johnson will be honored "in consideration of his fundamental investigations leading to the recognition, measurement, and understanding of the thermal noise in resistors which forms the basis for the understanding of signal to noise ratio in electrical circuits and justly bears the name 'Johnson-Noise'."

Four are named ASME Fellows

Four distinguished engineers are elected Fellows of ASME. They are: Ray N. Benjamin, vice president and chief engineer, Georgia Power Co.; Carey H. Brown, former superintendent of engineering and maintenance, Eastman Kodak Co.; George M. Muschamp, vice president in charge of engineering, Minneapolis-Honeywell Regulator Co.; and Thomas F. Perkinson, manager of transportation, General Electric Co.

Election to rank of Fellow in ASME is limited to engineers of "acknowledged attainment with 25 years, active practice in the profession and who have been 13 years a member of ASME." The four will be honored as a part of the ASME annual meeting December 4 in New York.

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QUALITY CONTROL

TO MEET YOUR SPECIFICATIONS...

Modern science is an ally of the men who work in Guyan Eagle's quality-control laboratory. Here, using the most modern scientific methods and equipment, skilled technicians maintain constant watch over the quality of Guyan Eagle products, to insure that the high standards established by management are met, and that the buyer's specifications are rigidly adhered to.

This is just one reason why Guyan Island Creek is such an excellent coal for industrial use — low ash, high fusion, high B. T. U. value and low in sulphur — an outstanding coal for the most difficult jobs. Order a trial car today.

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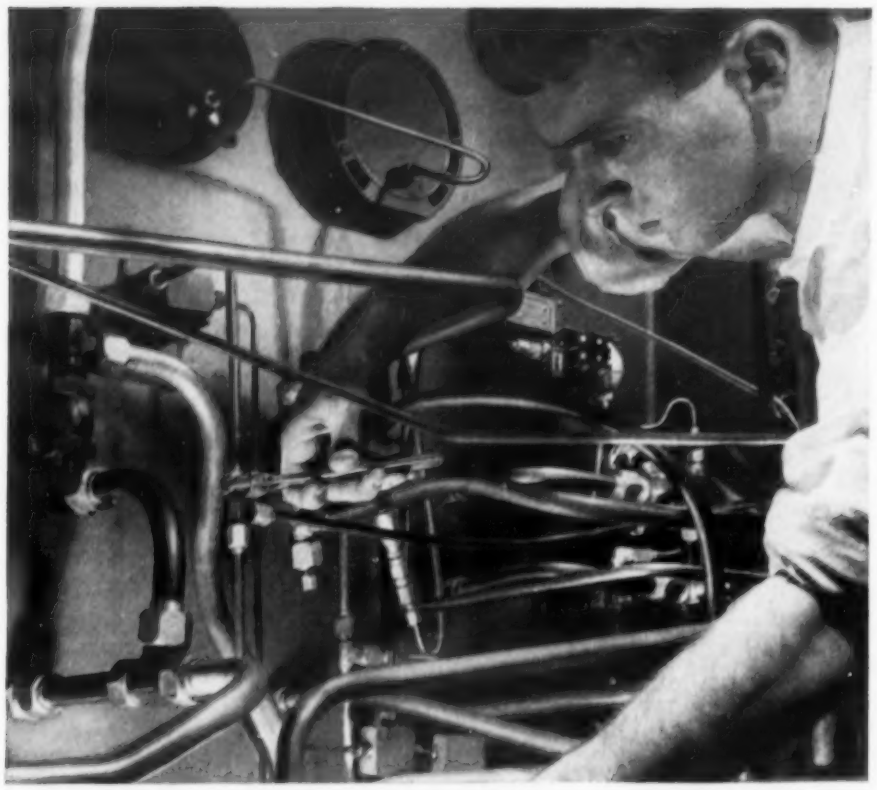

Fast, easy assembly with *Triple-lok* fittings even in close quarters, because of the low assembly torque. Yet *Triple-lok* remains absolutely leakproof under the severest conditions of vibration, high pressures and temperatures. *Triple-lok* is the flare fitting, famous for its sleeve — the industrial standard tube fitting. Meets specifications of the A.S.M.E. Code for Pressure Piping. Stocked in brass, steel, stainless steel, aluminum alloy. Made in other materials on special order. Send for Catalog No. 4310.

Easy-to-use Parker tube fittings for instrumentation and processing

Weld-lok. Easy to use. Simply insert tube, then weld. For extreme temperatures or corrosion conditions — wherever permanently welded joints are needed. Available in steel and stainless steel. Send for Catalog No. 4370.

Intru-lok. 3-piece flareless design fitting especially for instrumentation lines of ¼" through 1" O. D., copper or aluminum. Easy to install. Just insert tube, then tighten with regular wrench. Also for plastic tubing. Catalog No. 4324.

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Parker
Hydraulic and fluid system components

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this month's comment . . . .

. . . what do we think about unions for engineers?

Last month "Forum" presented pro and con viewpoints on "Unions for Engineers?". So as not to affect the presentation of that debate, we didn't comment editorially on the subject.

What is our opinion? We are opposed to unions for *engineers.*

But — who is an engineer? That definition is the key point that can clarify a lot of muddled thinking. We suggest it might help clarify matters to let the title "technician" be properly applied to men who use their training and experience in engineering science and methods strictly as *tools of their trade.*

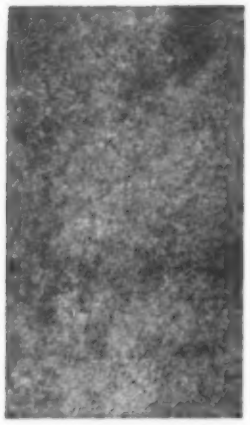
Then, the title "engineer" would be applied *only* to those men who not only use those tools but also are *professional men,* in the true sense of the term. To be a real professional involves adherence to a high standard of ethics on the job *plus* active support of professional societies (see comments on this subject on page 11 made by William Ryan, president of the ASME), *plus* participation in community affairs, *plus* the holding of a professional engineer's license, *plus* the continued obtaining of training and knowledge about the profession.

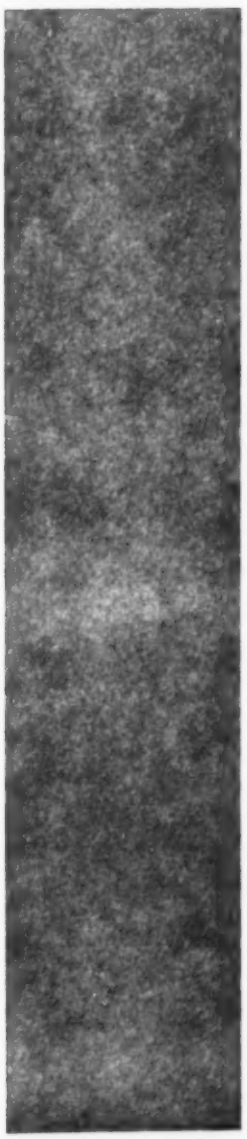
With such a differentiation and clarity of definition, we then have no debate. For "technicians," unions perhaps could be desirable, just as they have proved to be beneficial for many other trades. But for "engineers," unions cannot serve any useful purpose — can, instead, be a serious detriment to the development of the engineer as a responsible, professional man.

So — it's up to the individual. Is he a technician or an engineer? Is he just animated or is he motivated?

John Paul Taylor

John Paul Taylor
Editor and Publisher





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Power Industry

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Industry's role in supporting Engineering Societies

Dr. WILLIAM F. RYAN, President
The American Society of Mechanical Engineers

About Dr. William F. Ryan

Dr. William F. Ryan, 1956-57 president of the ASME, is vice president and senior consulting engineer for Stone and Webster Engineering Corporation. He joined Stone and Webster in 1929 as a mechanical engineer. He was named vice president in 1950, after having served as assistant chief mechanical engineer, assistant engineering manager, and engineering manager.

Dr. Ryan joined ASME in 1917 and has served in numerous committee, divisional, and delegate assignments for the society. He has served as ASME representative on the Engineers Joint Council-Engineering Council for Professional Development Committee on Practice of Engineering, and as advisory member of the Power Division Executive Committee.

He holds two degrees from Harvard College, an A. B. degree awarded in 1911, and an MME degree conferred in 1913. In 1954, Catholic University of America conferred upon him the degree of Sc. D.

In 1956, Dr. Ryan was elected a Fellow in the Royal Society of Arts in London and was awarded the David B. Steinman Medal by the Societe National des Ingenieurs Professionnels de France for his professional contributions and achievements.

Dr. Ryan is the author of numerous technical papers in the field of heat and power and professional ethics. He holds a patent on a dual-circulation boiler.

He is also active in other national and international organizations, including the NSPE, American Society of Engineering Education, U.S. Naval Institute, American Ordnance Association, and the International Electro-Technical Commission.

WISELY, AMERICAN industry has fostered engineering education. Every year, millions of dollars are appropriated by manufacturers, public utilities, service organizations, and other groups commonly classed as "industry" to support our engineering schools. The gifts may take the form of scholarships, fellowships, research grants or unrestricted gifts to engineering schools and engineering departments of universities. This has been going on for more than 100 years. In fact, our oldest schools of technology were founded by successful industrialists with the expectation that technical talent could be developed for the expansion and improvement of our national economy. That expectation has been fulfilled, thanks to the increasing support from industry.

the most and the best

This generous support has been offered *wisely*, because our engineering schools and their graduates have won for American industry the productive and profitable position it now holds. That fact was recognized by one of the world's keenest observers and most eloquent reporters. At the great mid-century convocation at Massachusetts Institute of Technology, the Right Honorable Sir Winston Churchill made the following observation: "We have suffered in Great Britain by the lack of colleges of university rank in which engineering and the allied subjects are taught. Industrial production depends on technology and it is because the Americans have realized this and created institutions for the advanced training of large numbers of high-grade engineers to translate the advances of pure science into industrial technique, it is for this reason that their output per head and consequent standard of life are so high."

At the moment, this country has more engineers than any other. We have not only the most, but the best. We may not be able to maintain our superiority in numbers, and there would be no earthly point in training more engineers than we need, but we can and we must maintain our superiority in quality.

who does society work?

In spite of certain blindspots in industry-engineering society relations, industry has been magnificently generous in donating time and expenses for key engineers to take part in engineering society activities. Substantially all work in our engineering societies: preparing technical papers, codes and standards; organizing meetings and conferences; and administering society affairs are performed by dues-paying engineering members. Most of those members are employed, and their time is a direct charge to their employers' overhead or cost of doing business. Frequently, in fact in the majority of cases, the men involved are highly paid and the time devoted to work is often considerable. There are isolated cases where more than half of an employee's time is devoted to society activities. In addition, the employee's expense for attending committee meetings and technical sessions is usually borne by his employer. I have heard of cases where an employer was willing to pay expenses for attendance at technical sessions, but not for committee meetings and other sessions when the subject was of a purely administrative or professional nature. Industry is interested in developing the whole man, not merely the technologist, and should support our engineering societies *in toto*, as the technical activities cannot stand alone.

Without the generous donation of time and expense from industry, our engineering societies would soon wither and die. Such support, particularly in the technological area, is almost universal, and is certainly a legitimate business expense. The quality of American engineering is the result of high-grade technical education in college, followed by unlimited opportunity for post-college professional development through engineering society affiliations. It is only logical that industry should be the chief support of that post-college development.

young engineers are not active

Again, however, there is a blind spot. Not enough *young* engineers (by young I mean men who received their first engineering degree less than 10 years ago) are participating *actively* in the work of our engineering societies. One finds that the large majority of engineers in attendance at national meetings are mature men, and the *very old* outnumber the *very young*. Older men have more to contribute to such meetings but they have less to gain than the youngsters. Both should be there. Young men are regrettably absent even from local meetings when they involve charges for a dinner or luncheon. Some students and some junior members attend ASME

(continues on page 17)

As we promised in our last issue, the editors of Power Industry present the results of a nation-wide survey on the real or alleged Engineering Shortage. As is the case with all progressive editorial, we have been, and shall be subject to plaudits as well as protests. To get the maximum benefit from any survey, the data must be analyzed to determine trends. Here is our analysis of . . .

POWER INDUSTRY's Engineering Shortage Survey

STAFF REPORT

ROBERT W. DE MOSS, Associate Editor

TO CLEAR the smoke-screen of confusion surrounding the real or alleged engineering shortage, the editors of POWER INDUSTRY have made a survey of today's practicing engineers. We feel that in spite of the well-meaning phrases of executives, politicians, and educators, the real answer should come from the man most concerned — You, the practicing engineer. Survey results are presented for your individual evaluation. We feel that definite trends are shown.

In this survey, our questions were intentionally aimed at getting below the surface and finding the true feelings of engineers.

Obviously (as shown graphically on opposite page), the majority of engineers surveyed believe that an engineering shortage exists. In spite of many statements to the contrary, this is the opinion of the men surveyed. However, the majority is not as overwhelming as might be expected.

Perhaps Question 2 pinpoints one of the reasons causing this shortage. Over 50% of the men questioned feel that their abilities are not being used to fullest advantage. This can be best substantiated by findings of the Manpower Investigating Subcommittee as reported by Representative James C. Davis of Georgia. The report states "There is evidence of lack of proper utilization in defense industries. A Navy report said a survey showed firms wholly engaged in defense business had about 35,000 engineers while contractors with preponderant commercial business had about 9000, yet the latter did a total of $250,000,000 more business annually."

Replies to Question 3 may shed further light on the shortage. An overwhelming majority of those questioned feel that they are not being compensated (by salary) in the same proportion as the professions of medicine and law. The reason for this "underpayment" for services rendered may lie deeper than the mere idea of professional recognition. Does not the fact that the legal and medical professions deal principally with people rather than things, have a decided effect on the financial remuneration involved?

To further emphasize replies to this question, let us quote from the proceedings of the Symposium on Industrial Research at the 61st Congress of American Industry, sponsored by the National Association of Manufacturers. Dr. John R. Dunning stated ". . . if you gentlemen in industry want to solve the engineering and scientific shortage problem, the straightforward solution is simply to double the salaries of your engineers and make a reasonable ratio between engineers and skilled labor. Word will then get into the high school, 'If you go into science and engineering, it is almost worthwhile; you will get paid more than a welder or bricklayer." These words, more than anything else, may contain a solution to the problem.

In Question 6, the "bugaboo" of salary compression is given an open airing. Assuming an even split among those who did not answer this question, we have an overwhelming number (three out of four) engineers who feel the effects of salary compression. Perhaps the answer to this problem lies in a statement by Dr. Herbert R. Northrup, vice president, Penn-Texas Corporation, at meeting of NAM Committee on Research, February 15, 1957 — "In determing professional compensation, management might well consider these three rules:

- Have an objective current salary evaluation so that job content is fully determined
- Pay a salary based on reasonable area-industry considerations
- Keep the salary and prerequisites of professional personnel well above the rank and file worker."

Questions 4 and 5 should be considered as a pair. The appalling conclusion derived from the replies to these questions is that we have, in addition to a recognized shortage, a force of approximately 190,000 (based on National Science Foundation data) practicing engineers who are not promoting the engineering profession. How many are actively promoting the profession? In addition, one engineer in five is dissatisfied with his chosen profession and would prefer to be in another field.

In spite of the fact that many engineers are dissatisfied with the "status quo," only about 12% feel that unions would benefit engineers. This percentage will increase or decrease, depending upon steps taken by both management and the engineering societies to get to the bottom of this problem.

Answers to the essay-type Questions 8 and 9 varied from terse to flowery, from meek to bellicose. In all replies, however, the tone of concern and interest was present.

In general, the main themes of poor pay and poor utilization of available engineers' abilities led the list. Some answers echoed political sounding boards by placing all the blame on our educators. Some have been so imbued with political prattle that they advocate government intervention in selecting College curricula. Again, the statements by Drs. Dunning and Northrup come to mind.

Answers to Question 9 follow the trend in Question 8. Those who mentioned low pay as the reason for the shortage advocated pay increases as the solution. Those who mentioned malutilization of engineering ability advocated better, more efficient use of engineers.

The aesthetic concept of the brilliant engineer working alone in his ivory tower to benefit mankind must be compromised with the everyday problems of modern living. While the average engineer prefers to believe that his ability will be recognized (by either monetary gain or professional recognition), he is becoming increasingly doubtful of this policy. Not all engineers are a Steinmetz, an Edison, or a Marconi. The demands of family and society urge him to seek income increases even if it means leaving his chosen field. The salary inequities he sees all around him increase this feeling. Management and the engineering founder societies must become leaders in solving this problem. The solution lies not only in getting more new engineers but also in keeping ones already in the fold.

Many interesting intangibles

came to light in the survey. For instance, the majority of new engineers felt very strongly that engineers should receive more professional recognition. Further, those engineers questioned who were registered professional engineers did not hesitate to sign their replies, add P.E. after their signatures, and include their registration number. This is as it should be. Another interesting fact – Although the questionnaire specifically stated that signatures were not necessary, over 70% of the replies were signed or initialed.

The survey results have shown the true feelings of practicing engineers throughout the United States. To speak dogmatically about the results of any survey brings to mind the saying "Every story has three sides – Yours, mine, and the facts". While we do not intend these results to be taken as a cure-all for all engineering ills, we are justifiably proud of the response to our questionnaire (37 1/2% of our single, unsolicited mailing were returned). We feel (as is proven by the survey results) that the time is ripe for management and the engineering societies to take a more active role in solving this problem. The consensus is behind them. What more can they ask?

Dr. William F. Ryan's comments on POWER INDUSTRY's survey.

It is rather staggering to find that less than half of our engineers consider their capabilities are being used to the fullest advantage. Nevertheless, it is undoubtedly true that in many engineering organizations engineers are inadequately staffed with auxiliary talent both technical and clerical and the shortage could be alleviated to some extent by better organization in engineering departments. Perhaps the most significant feature of the questionnaire is that 88% of the engineers consider themselves underpaid, but 78% would choose an engineering career if they could live their lives over and 71% would encourage their children to study engineering. No clearer demonstration could be asked that engineers are not motivated primarily by financial considerations. If they are underpaid in money, they derive intense satisfaction from their work.

Engineers, here are the facts for your evaluation. Do you agree with the editors' analysis? How would you answer the questionnaire? Write your comments to the editors of POWER INDUSTRY.

What engineers think of their profession

1) Do you believe that there really is an engineering shortage?

YES	56.7 %
NO	39.7 %
NO ANS.	3.6 %

2) Is your education and experience presently being used to the fullest advantage?

YES	48.3 %
NO	50.6 %
NO ANS.	1.1 %

3) Do you feel that engineers are compensated (by salary) in the same proportion as the professions of medicine and law?

YES	8.8 %
NO	88.0 %
NO ANS.	3.2 %

4) If you had your career to choose over again, would you choose engineering?

YES	78.4 %
NO	19.8 %
NO ANS.	1.8 %

5) Would you advise your son, nephew, cousin, or other high school students to study engineering?

YES	71.4 %
NO	20.3 %
NO ANS.	8.3 %

6) Is your present salary adequate (based on your years of experience) as compared to starting salaries now being offered to graduates?

YES	23.0 %
NO	73.8 %
NO ANS.	3.2 %

7) Do you feel that engineering unions benefit engineers?

YES	11.9 %
NO	81.7 %
NO ANS.	6.4 %

Some typical remarks:

8) What single item, more than anything else, do you think has contributed to the current engineering shortage?

Low salaries – Using engineers in non-engineering tasks – Salary compression.

The fact is that the engineer is the best jack-of-all trades in the industrial field. If you need a clerk, a scientist, a foreman, a draftsman, etc., just ask for an engineer. He is a good producer, doesn't cost much relative to his work output, and never causes any trouble.

Engineers who have not found adequate compensation, monetary or otherwise, leave the profession for other fields.

The lack of future in pure engineering, forcing engineers into management.

Lack of engineering societies promoting interest in their profession in the grade and high schools.

The inconsistancy between the HIGH wages paid to union laborers today – and the low salaries being paid to engineers.

9) What do you recommend be done to obtain more qualified engineers?

Increase salaries – Use available engineers to better advantage – Increase professional recognition, weed out undesirables.

A better selling job by engineering societies.

We need more qualified engineers –not a mass production substitute. Economic and social recognition along with job satisfaction. Industry holds back a big percentage of all progressive thinking.

Would not recommend increase (engineers). There is no more room at top positions than when there were fewer engineers. Consequently, engineers must remain in the lower pay brackets.

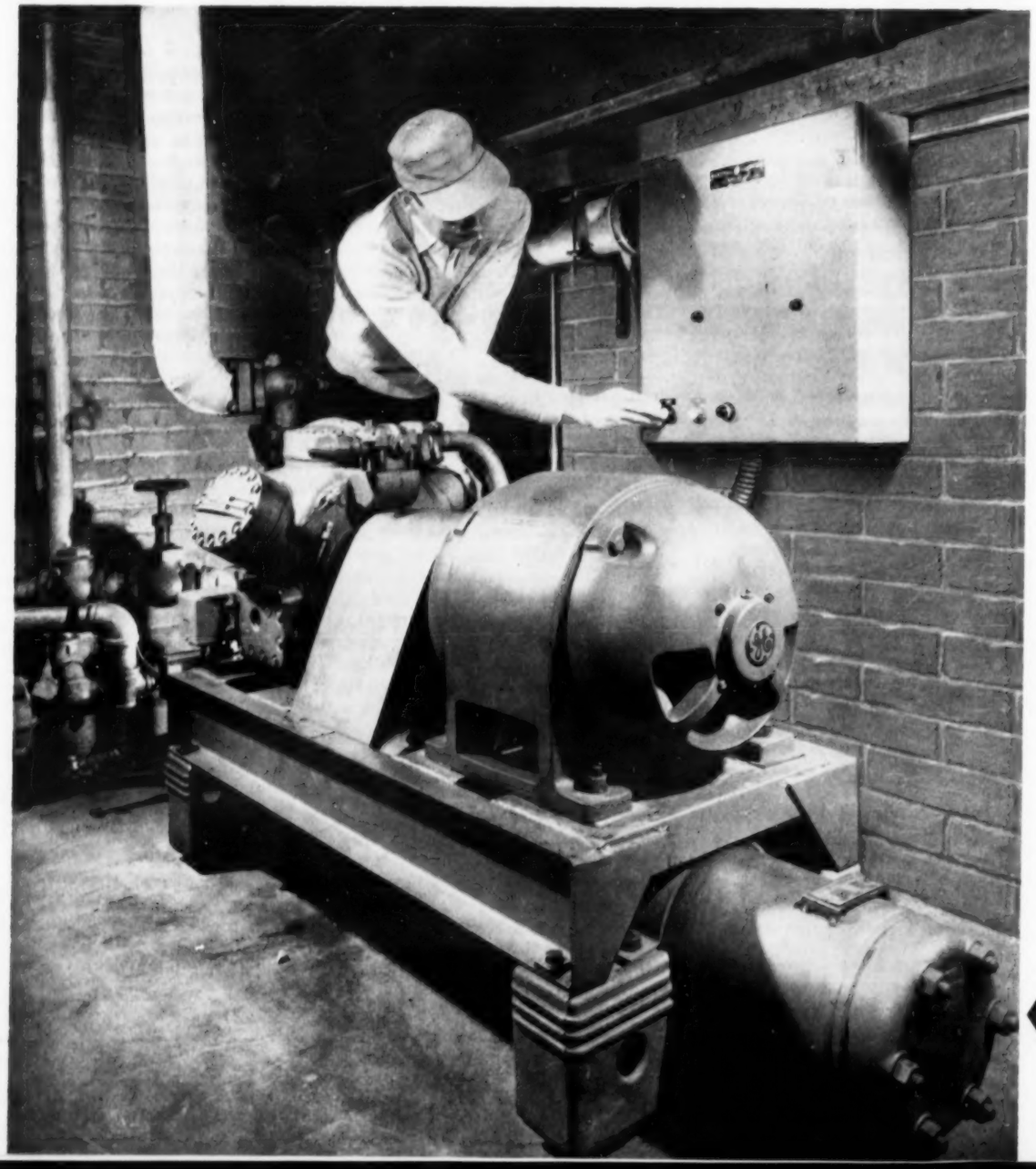
Require "all" engineers to be licensed in order to use the word "engineer"–.

More muscles for your motors with . . . .

Better part-winding starting

Get new performance and versatility in starting heavy polyphase motors with an improved, low-cost switching method that even handles nine lead delta-wound motors with ease.

P. L. ALGER, Consulting Engineer
J. SHEETS, Manager, Panel Production Engineering
General Electric Company



PART-WINDING STARTING is one of several methods used to limit current surge when starting polyphase motors. Without such methods, the motor must be connected directly across the line. Starting currents will reach about six times normal full load running current in a surge that may momentarily upset the power system. The result may be faulty operation of control circuits, light flicker, and possible penalties on the power bill.

- Part-winding method requires a motor with two windings that can be connected in parallel under running conditions, as with a dual-voltage motor operated on the lower of its rated voltages
- It is attractive in that it avoids autotransformers, resistors, or reactors needed by other methods of primary current control
- It has been limited to low inertia loads, or to increment starting where, as is sometimes true, the peak starting current can be tolerated provided it is reached in a series of two or more steps. The new arrangement reduces some of these limitations.

The method now commonly employed uses two similar 3-pole contactors, each connected to one of the motor windings (Fig. 1). In starting, one contactor is closed first so that only one-half the motor windings are drawing current.

Instead of the conventional arrangement, the new panel has one four-pole contactor, P, and one two-

New Tri/Clad motor, connected to refrigeration compressor, is easily started with a part-winding starter.

pole contactor, Q (Fig. 1), each selected for one-half the rated line current of the motor. In addition to permitting the half-winding connection just mentioned, it allows two-thirds of each winding (two-thirds of the total motor windings) to be active on the first step.

what are the advantages of this method?

With variations to be discussed later, the new arrangement starts any standard six- or nine-lead polyphase motor, with Y or delta connection, in two steps with less than two-thirds of the locked-rotor current for the full winding on the first step. It also provides a choice between increment starting (generally using the half-winding connection) and true part-winding starting (generally using two-thirds winding on the first step).

In the first case, the full winding is closed in after one or two seconds, when the total current rises to about the same value as in full-winding starting. In the second case, the motor comes to full speed before the full winding is closed in, and the current does not increase above its initial value of about 65% of the full-winding locked-rotor current.

Accelerating torque margin, however, is small with any form of two-step, part-winding starting. For high-torque, high-inertia loads, either increment or three-step starting will be required.

let's see how the two-thirds winding works

For example, to start a Y-connected motor on two-thirds winding, contactor P, Fig. 1, is closed. This forms two single-phase, line-to-line circuits energizing two-thirds of the total windings. The two circuits are displaced in space and their voltages are displaced in phase. This gives starting conditions similar to those of a two-phase motor. Although line currents are unbalanced, current is the same in each contactor pole and throughout the active portions of the windings.

Fig. 2 contrasts typical speed-torque and speed-current curves when starting on one-half, two-thirds, and full winding. On half winding, there is a severe dip in the torque curve that may go below zero. This means that the motor will not accelerate beyond this point. Closing in the full winding with the second contactor transfers current and torque conditions to the full-winding curves where, at low speeds, the current has only slightly reduced from standstill conditions.

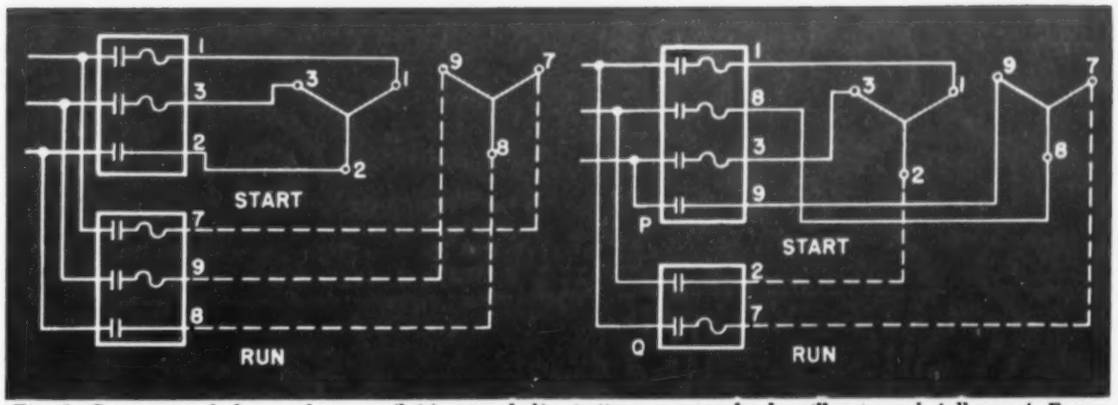


Fig. 1—Conventional three-pole start, (left) using half windings, causes shock, will not reach full speed. Four-pole start (right), using two-thirds of each winding, gives smoother acceleration through range to full speed.

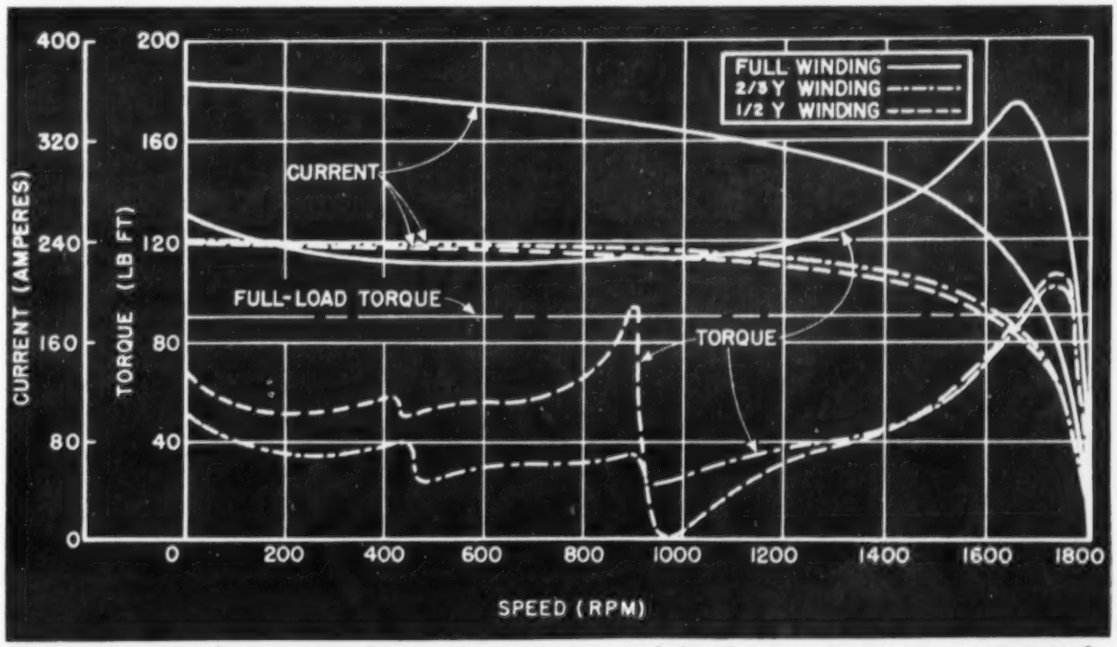


Fig. 2—Solid curves show current and torque if motor is connected directly across line in starting. Part-winding starting reduces both, but torque on two-thirds winding starts low and stays more even throughout range.

Dip is due to a harmonic field caused by omitting half the motor coils from the active winding. With two-thirds winding and fewer idle coils, the dip is much less, and the motor will usually come up to speed on the first step. When the full winding is closed in by the second contactor, transfer current should not rise above the initial value.

Severity of torque dip and speed at which it occurs depend on the sequence of idle coils in the motor windings. None of the thirteen possible patterns in a four-pole motor gives a smooth torque curve when normal coil throw is used. With a high-resistance rotor, minimum torque can be made adequate, but this reduces motor efficiency and increases heating.

With the preferred standard asymmetric winding arrangement (alternate poles in series and leads 1, 2, and 3 brought out from adjacent phase belts), using two-thirds of the winding will give only a small dip in the torque curve. Usually the minimum torque is enough to bring the motor to speed on the first step, although the margin available is smaller as motor size and speed increase. The two-thirds winding should always give a higher accelerating torque and less noise or vibration than the half-winding connection.

In all cases, the second contactor (Q in Fig. 1), is closed after a suitable time delay, controlled by a timer on the panel. When the motor is not expected to accelerate to full speed on the first step, the timer is set for only one or two seconds delay. Closing the second contactor will then increase the line current to nearly the full-winding, locked-rotor value, or about six times full load current. In this case, increment starting (rather than true part-winding starting) is obtained.

When the motor is expected to accelerate to full speed on the first step, the timer may be set for five

(continues on page 26)

Protecting a 30-in. pipe

J. F. BOSICH
Diamond Alkali Co.

EVERY DAY THE Painesville, Ohio plant of Diamond Alkali Co. uses over 100 million gallons of Lake Erie water, with a total hardness of 130-200 ppm.

A 30-in. cast iron pipeline supplies water to about one-half of the plant. It is a branch of the main header from the main pumphouse and is not coated. It is very important that this line be in continuous operation, since a failure would result in the shutting down of about one-half of the plant and seriously hampering production.

About 1000 feet of the pipeline is located adjacent to a large coal storage area. In July 1953, a leak developed in the pipe due to pitting corrosion. An analysis showed that water coming from the coal pile contained 17.13 grams per liter of sulphuric acid. The leak was patched by placing and calking a ½-in. steel sleeve around the line. In June 1954, another leak developed through the sleeve.

The leak was again patched and the section where the leak occurred was coated with a heavy layer of hot tar enamel reinforced with Fiberglas cloth. Drain tile was placed at this point to divert the stream of ground water coming from the coal pile.

A survey was conducted in August 1954, by Harco Corporation in cooperation with Diamond Alkali Staff Engineers. The results indicated that severe local galvanic action was causing these leaks. Excavation in the leak area exposed ground water flowing toward the pipeline from the direction of the coal pile. Resistivity of this water was found to be 40 ohms/cm³, and average resistivity of the soil at a depth of 9 feet in the leak area was found to be 520 ohms/cm³.

We believed that cathodic protection would be practical if sufficient current could be applied to this bare line. A temporary ground bed was installed and test currents applied. Pipe-to-soil potentials and voltage gradients were measured along the line. Because of the high current requirements, a graphite anode system powered by a rectifier was considered to be more economical than a large number of magnesium anodes. To distribute the current properly, the anodes were installed close to the pipe along its whole length.

The system was energized with rectifier output of 70 amperes Tests indicated that about 700 feet of the pipeline was receiving adequate cathodic protection. The system was left operating at this output to permit polarization of the line. In November 1955, after ten months' operation, and with rectifier output of 68 amperes, pipe-to-soil potentials along the line indicated that the full thousand feet of line was protected.

After two years of cathodic protection on the pipeline, no further leaks in the pipe are reported. The use of cathodic protection not only stopped the leaks, but also prevented further failures. The system is guaranteed to adequately protect the pipeline for at least 20 years before any graphite anodes will require renewal. ♦♦

It wasn't the pumps but the piping

GORDON D. BROWN
Union Carbide Chemicals Co.

VIOLENT FLASHING and water hammer problems were troubling the Utilities Division, Union Carbide Chemicals Co., South Charleston, W. Va. Two Byron-Jackson Pumps, Inc. re-entry boiler feedwater pumps rated 347,500 lb/hr, 1640 ft head at 5000 rpm, installed in 1954, were supplying feedwater for a 289,000 lb/hr, 600-psig boiler.

One pump supplies feedwater to the boiler, the second is used for standby service. Each pump is a re-entry pump, which is essentially two pumps on the same shaft. The primary pump takes suction from a low-pressure feedwater heater and pumps to an open-type high-pressure heater at 200 psig. The secondary pump takes suction from the 200-psig heater and pumps direct to the boiler.

One pump was placed in service on September 30, 1954, using the 10-psig feedwater heater only. Boiler operated at a rating of 170,000 lb/hr for 4 days without difficulties.

On October 4, while admitting 200-psig steam to the high-pressure heater, violent flashing occurred in the low-pressure suction line to the feed pump. This flashing and violent water hammer occurred when water temperature reached 320 F in attempting to put the high-pressure heater in service.

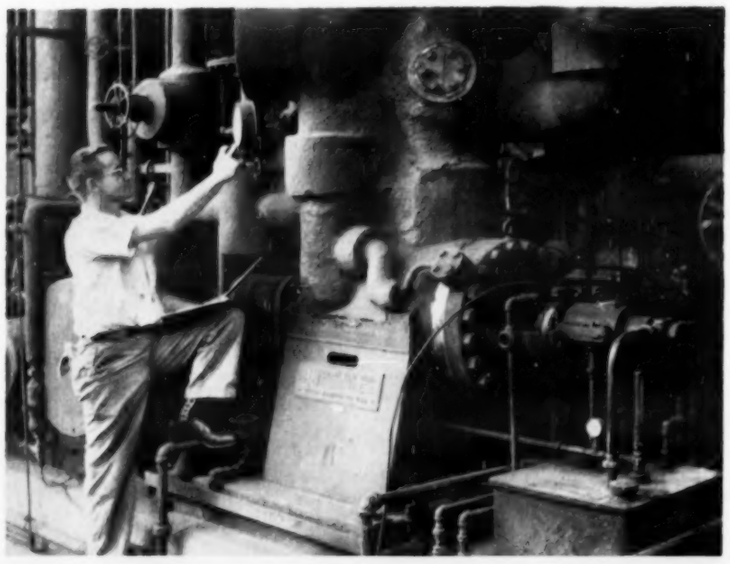
After inspection by Byron-Jackson Pumps, Inc. representatives, the standby pump was put into service with the high-pressure heater. Extreme flashing and water hammer occurred immediately.

Further tests were tried, including introduction of cold water into the pump suction, hydrostatically testing the high-pressure barrel, and interchanging pump volutes. Each pump was then tested alone.

Tests indicated leakage through the idle pump from the high-pressure side to the primary pump. This leakage caused bubbles to develop and travel to the low-pressure suction of the operating pump through the common suction line with subsequent water hammer and flashing occuring.

To eliminate these problems, the common low-pressure suction line to the two feed pumps was vented with a 3-inch line back to the low-pressure feedwater heater. This vent line permitted steam bubbles to return to the low-pressure heater.

So, in the final analysis, the fault was not in the pump, but in the piping. ♦♦



Industry's role

. . . starts on page 11

national meetings at the expense of The Old Guard, a group of elderly Life Members who no longer pay dues to the society but who contribute the equivalent for such purposes.

A young engineer develops professionally, first through his own day-to-day job, if it is genuine engineering work requiring exercise of discretion and judgment as well as technical knowledge and skill; second through reading; and third through association with other engineers. The professional society offers the best in self-education through its journals and transactions. It provides the engineer with almost the only opportunity for exchange of knowledge and ideas through association with other engineers outside the limited circle of his own company. There are many engineers who go through life without ever joining an engineering society. Some are successful, but not many. They are the stuff of which engineers' unions are made. An employer is making a dubious investment when he hires an engineer who has no engineering society affiliations.

ASME and many of our sister societies make it very easy for the young graduate of an accredited curriculum to become a member. As an undergraduate he may join a Student Section. If he does, he automatically becomes an Associate Member when he receives his degree. Young engineers, receiving the starting salaries now prevalent, who reject that opportunity for professional affiliation, are obviously lacking in professional consciousness. That may be due, and I believe it usually is due, to that narrow technical education of which many complain. They may be masters of technology but they are professionally illiterate. If that is due to faulty education, and I regret to say that some engineering schools turn out such men, then guidance from employers and fellow employees is in order.

In my opinion, professional registration as an Engineer in Training should be as simple as acquiring Associate Membership in ASME. A graduate of an ac-

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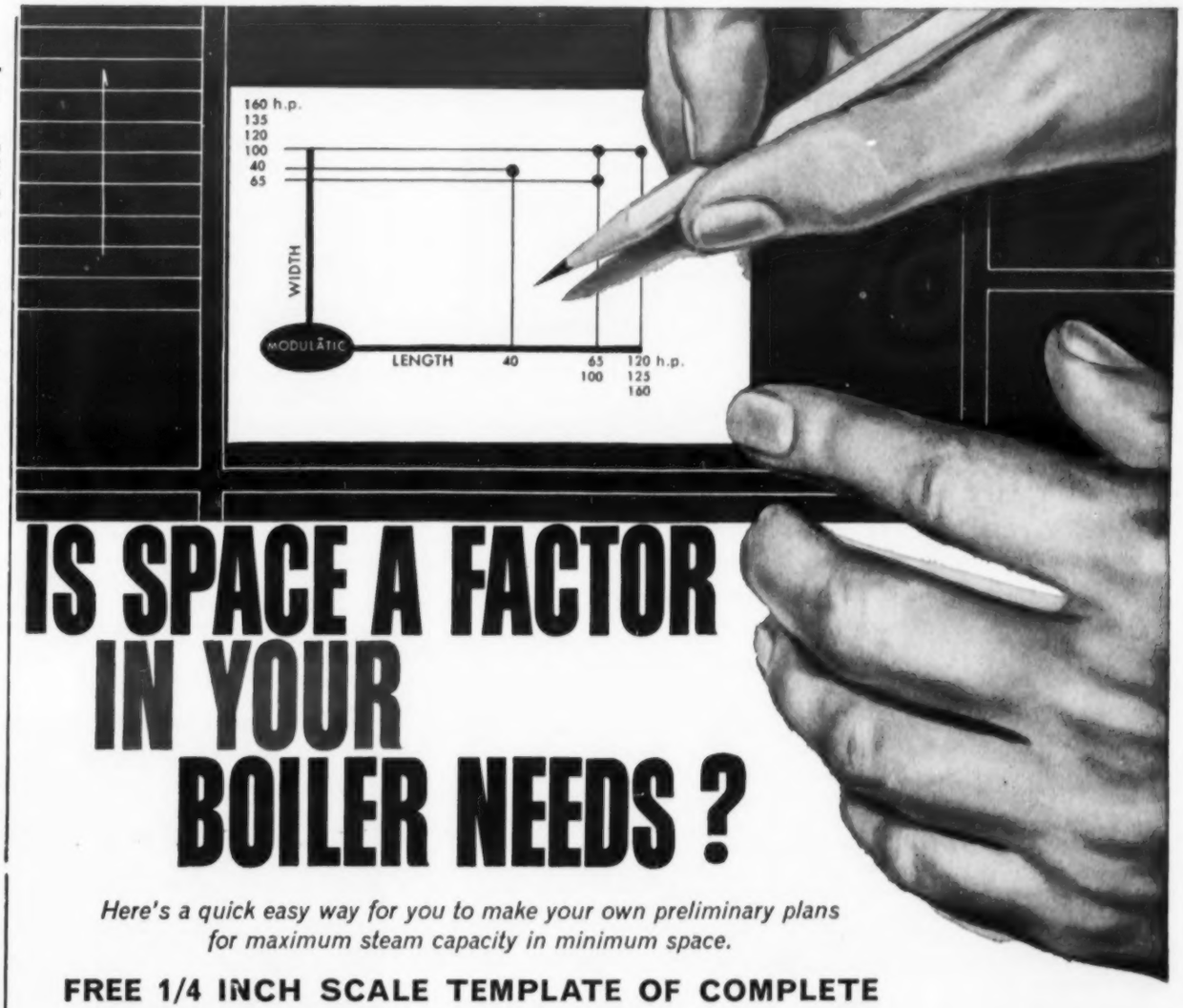

IS SPACE A FACTOR IN YOUR BOILER NEEDS ?

Here's a quick easy way for you to make your own preliminary plans for maximum steam capacity in minimum space.

FREE 1/4 INCH SCALE TEMPLATE OF COMPLETE VAPOR MODULATIC WATER TUBE BOILER LINE MAKES BOILER NEED PLANNING SIMPLE

Set the template on your floor plan and select the size boiler you need—experiment with locations. Modulatic needs no enclosures, no chimney, no foundation. Put it where you want to use steam. On the roof, on a balcony, in an aisleway, hang it from the ceiling or put it in the basement. Proved by 25 years in America's toughest boiler rooms! 10 horsepower to 160 horsepower. From 5 pounds to 300 pounds pressure (higher when required).

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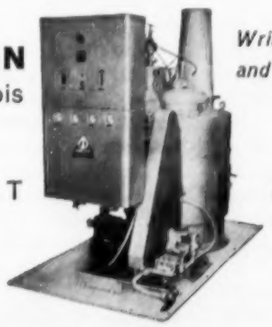

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THE WORLD'S MOST COMPACT POWER PACKAGE

Circle 144 on Reader Service card for more data

Eliminate power house window maintenance

JAMES J. PRENDERGAST
Superintendent of Utilities

JOHN A. MOLK
Supervisor, Plant Engineering

Locomotive and Car Equipment Department
General Electric Company

INSULTED METAL panels save maintenance dollars for General Electric's Erie, Pa. power house . . . . and will pay out in 5 years while promising a useful life of at least 20 years. Scissors-type operators for glazed sash had been installed when the power house (Building No. 4 at Erie) was built in 1918. Continuous glass breakage and resulting high maintenance led to replacing with rack-and-pinion type sash operators in 1951. But glass breakage and maintenance costs remained high.

Heat penetrating the west wall of the turbine room on sunny summer days forced operators to open the sash. Sudden, severe wind and rain storms, typical of the Great Lakes region, often came up faster than the sash could be closed. Prevailing west winds whipped and twisted the sash to the point of breaking the glass and interfering with the closing mechanism. Even with the sash closed, leaks often developed that periled switchgear located just under the sash inside the west wall. Furthermore, sun beating in through the sash inter-

(continues on page 41)

Pipeline Overcoat Saves $

PIPING STEAM THROUGH an uninsulated pipeline is like trying to carry water in a leaky bucket. Similarly, pumping viscous fuel oils, even heated ones, through an uninsulated pipe is a frustrating proposition at best.

The solution is heat conservation. That's why the Esso Standard Oil Company recently installed a $250,000 pipeline overcoat, lined with mineral wool and weatherproofed with sheet aluminum. Esso estimates the overcoat will save more than a half-million dollars worth of heat annually. It maintains temperatures of fuel oils, water, and steam being exchanged, between Esso's Baywav Refinery and the Linden Station of Public Service Electric and Gas Company through more than 6 miles of large-diameter pipeline.

Insulation thicknesses were applied to each line according to product carried:

Line Used For	Line Size
Steam-traced HV fuel	3½ in.
HP steam	2½ in.
LP steam	2 in.
Bunker C	2 in.
16-in. steam	1½ in.

Immediately after being secured, insulation was covered with 15-lb roofing felt. The felt not only protected insulation from rain and moisture until the final aluminum coating was in place, but also prevented possible galvanic action because of contact between aluminum shell and steel lath.

According to Esso engineers, the insulating jacket reduced heat loss in the steam lines, compared to uninsulated lines, by approximately 95%. And, cost of the overcoat will be paid out in six months, based on estimated heat savings. ♦ ♦

What you need in power plant records

J. M. TOTTEN
Stone & Webster Engineering Corporation

TODAY'S POWER PLANT cannot be operated intelligently and maintained properly without an adequate and comprehensive record system.

Considerable thought must go into the preparation of a good record system.

Good record keeping makes it possible to:

- Determine costs of operation
- Detect faulty operating practices, inefficiency, and inattention
- Detect promptly physical changes in equipment that are reflected in performance
- Schedule maintenance work so that unexpected equipment failures are held to a minimum
- Compare results obtained with varying fuel grades, with variations in water treating methods, and with other operating procedure changes
- Determine accurately life of wearing parts
- Predict growth rates in demand for electricity, steam, heated water, compressed air, refrigeration, etc.
- Determine most economical equipment retirement time
- Determine whether additional capacity should be installed
- Schedule working force, minimizing overtime costs
- Analyze operating irregularities.

In brief, a good record system tells us what comes into the plant, what goes out, and a great deal about what goes on in the plant. . . continuously.

Let's look at the basic features of a good record system. Some information must be continuously recorded. For this we employ recorders or combination recorder-controllers. Other information is re-recorded at hourly intervals, with conventional log sheets.

Daily records usually comprise integrator reading or important metering devices, average values from hourly readings of significant items, service hours of equipment, tank gaging data, revolution counter readings, weigh scale tickets, labor time records, and similar information. Monthly and annual records are, of course, derived from hourly and daily records.

Here are some of the records needed to obtain intelligent appraisal of operations:

- Daily log sheets
- Log books
- Repair work orders
- Monthly operating reports
- Storeroom records
- Maintenance records
- Personnel records
- Instrument charts
- Performance charts
- Automatic data logging systems.

Unless kept intelligently and interpreted systematically, records are a waste of time and effort. Any record system should be reviewed critically from time to time, and revised as necessary to maintain its effectiveness. ♦ ♦

credited curriculum undoubtedly has the grasp of theoretical engineering required for EIT registration. However, 52 registration laws in our U.S.A. require an examination for that recognition, and any young engineer who has an accurate concept of his professional status will take the examination and secure an EIT rating. As soon as he is eligible, he will take the final examination and become a Registered Professional Engineer. That program is definitely recommended by ASME and industry should support the society by encouraging registration of their engineering employees and by offering financial assistance for refresher courses.

When an industrial concern has hired an engineer well grounded in technology and with an emerging sense of professional responsibility, why not encourage his development in both areas? I am not proposing that employers should pay their employees' initiation fees or dues in an engineering society, although many do. I merely recommend that, as a matter of enlightened self interest, young engineers should be allowed time and reasonable expenses for attending engineering meetings, both local and national. They should be encouraged to prepare papers or to participate in discussion of papers, and to serve on engineering committees. They should be encouraged to complete their professional registration as a matter of professional recognition, even though registration may not be required for their particular duties.

It is a healthy situation when the men who produce the world's best product are not satisfied with their own work. Engineering education will certainly improve, but it does not end on commencement day.

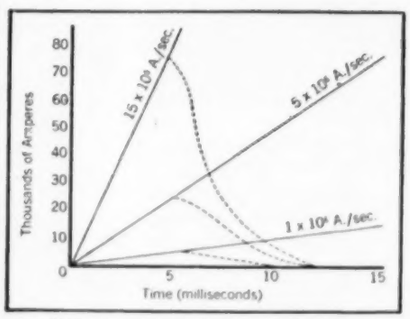
The young engineer needs professional contacts more than the older man, but he is less able to afford them. Encouragement by his employer for active participation in the work of engineering societies will return many benefits including a better equipped and more loyal employee, and it constitutes a definite contribution to the development of the engineering profession on which American industry depends for its future health and progress. ♦ ♦

D-C CIRCUIT BREAKERS

Type FB-20 single pole circuit breaker: 2000 amperes continuous, 1000 volts d-c.

NEW "FB" CURRENT LIMITING CIRCUIT BREAKER

Now...complete current limiting protection against fault currents of 1000 to 150,000 amperes



Peak let-through current for FB circuit breaker with 1000 ampere trip.

Small in size, these FB d-c circuit breakers with fast current limiting action provide a tremendous protective capacity. In the event of a fault, powerful springs open the contacts before the current has a chance to rise to its maximum potential.

Even in circuits where the rate of rise might approach 15,000,000 amperes per second, let-through current will not exceed 80,000 amperes. In most applications, it will never exceed 30,000 amperes—and total interrupting time is only 12 milliseconds. This quick action reduces the magnitude and duration of fault currents—thus eliminating mechanical failures and heat damage.

FB circuit breakers are available in either single or double pole models and with continuous current ratings of 1200, 2000, 3000 and 5000 amperes and up to 1000 volts d-c. They are available with either stationary or drawout mounting. Write for Bulletin 3004-A. I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

IN CANADA: EASTERN POWER DEVICES LTD.

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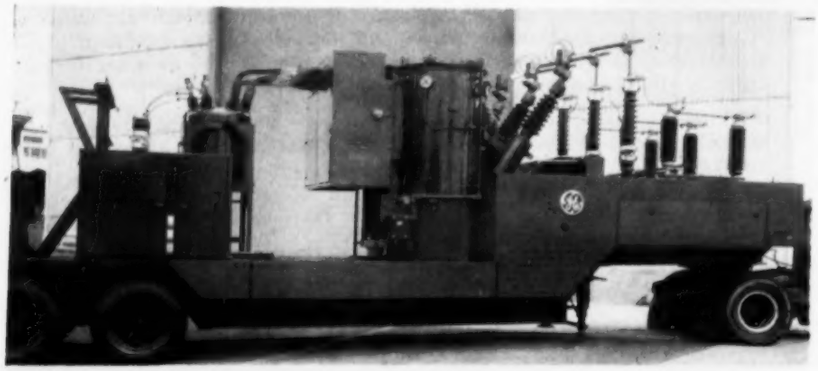
Photo News

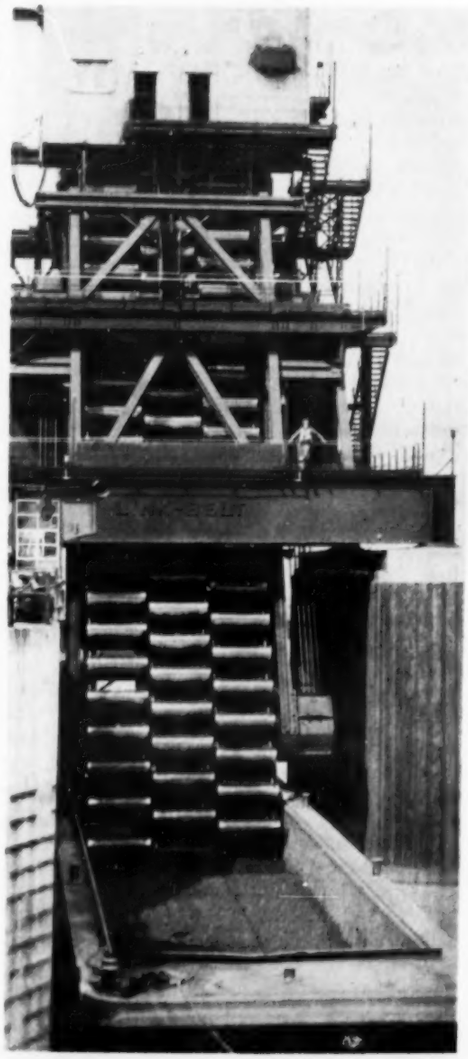
DEMONSTRATING THAT a coal-burning power house can be kept "clean enough to eat in," Delco Products Division, General Motors Corp., served lunch on the operating floor of its Dayton, Ohio, power plant at a recent Power and Utilities Committee meeting. Plant supplies steam and standby power for Delco's modern suburban factory, has latest equipment for smoke control.

LITTLE STEEL BB's . . . 35 tons of them . . . are installed as shielding in new "hot cell" at Westinghouse Electric Co.'s radiation and nucleonics laboratory. Cell has half-inch thick steel walls spaced 15 inches apart. BB's fill space between walls, equal 10-inches of solid steel in ability to contain atomic radiation. Using BB's, cell is portable, since shot can be drained for moving.



DIRECT CONVERSION of chemical energy of gases into electricity is accomplished with development of first practical fuel cell. Single cell consists of 9 hollow porous carbon electrodes grouped in round plastic housing. Carbon header on each end channels hydrogen and oxygen gases into proper electrodes. Electrical connections conduct away power. Here, Dr. Karl Kordesch, responsible for development of cell at research laboratories, National Carbon Co., holds one of the specially treated carbon electrodes.

HERE IS continuous barge unloader designed by Link-Belt Co. for U. S. Steel's Clairton works. Unloader's 141 buckets empty 900-ton coal barge in one-half hour.



HUGE TRAILER-MOUNTED mobile substation goes to work for Puget Sound Power & Light Co. Built by General Electric Co., it is designed to bypass permanent substations when regular equipment is laid up. Unit, with 9000-kva capacity, is available for fire, flood, or civil defense disaster needs.

Coal for the digging

BURIED TREASURE, in the form of thousands of tons of coal fines, is waiting for removal at the bottom of the Susquehanna River. These small pieces of anthracite coal were washed down with river current from coal mines over a period of 175 years.

Studies of the river bed indicated that approximately 18 million tons of coal-impregnated material lay beneath the water. This source of power (enough to provide low-cost fuel for a Pennsylvania power company for approximately 40 years) could not be ignored. The problem was to obtain modern machinery to recover the "river coal" efficiently and economically. Since removal of waterbound solids was involved, it was apparent that a hydraulic cutterhead dredge especially designed for this project was the best machinery obtainable. After a careful survey of dredging requirements, a 14-inch hydraulic dredge was selected. The dredge is equipped with the necessary auxiliary machinery to discharge coal-bearing silt into barges for towing to a recovery plant ashore.

In addition to the usual agitating machinery and pumping system, the dredge is equipped with the superstructure of a rotary trash screen. It receives full discharge of the dredge pump and removes all trash, primarily driftwood. The main operating part of the screen is a slowly revolving drum perforated by numerous holes. Waterbound silt passes through the drum perforations and into long chutes leading to barges on both port and starboard sides. Trash remaining in the drum is then passed into a large chute projecting at the stern.

From the loaded scows, muck is pumped through a pipeline to the coal recovery plant where fines are separated from silt by two operations. The water-laden coal, after being deslimed, passes into a mesh screen. The oversized goes to coal tables, where an elliptical shaking motion hastens separation and causes sand to fall out of its grooves to disposal lines.

Material passing through the screen is separated by a flotation process. Since it has an affinity for coal, oil is used in this step. When waterbound silt and oil are mixed and agitated, the latter carries coal particles to the top where they are drained off while inorganic materials settle to the bottom, becoming sludge for disposal.

Working 24 hours, 8 months of the year, the dredge is recovering over 1 million tons of coal-bearing silt and mud per year for the processing plant. From this material, approximately 500,000 tons of coal are reclaimed for use in the power utility's two steam plants. Attesting to the economy of the overall operation is the fact that the cost in bunkers at the steam plant is about one-half that for bituminous coal at normal plant use.

Hydraulic dredging is the most efficient and economical means yet devised to move waterbound solids. Public power utilities, in ever increasing numbers, are employing it to eliminate silting and channeling problems at their plant sites. Two basic reasons for this efficiency and economy are contained in the very nature of the dredging operation itself. First, hydraulic dredging is carried out by an excavator that can dig, transport, and relocate waterbound earth materials all in one continuous operation. Second, a hydraulic dredge has the added advantage, especially important to plants, in that it can do its work without causing the installation to curtail or temporarily cease operations. ♦♦

Spot fire protection pays out in four months

R. J. RACE and R. D. STOCK
Scripto Inc.

WHAT DOES A NEAR PERFECT fire-loss record cost? Five Atlanta plants of Scripto Inc. annually *save* three times the cost of their fire-protection system in reduced insurance payments. More important is the safety factor.

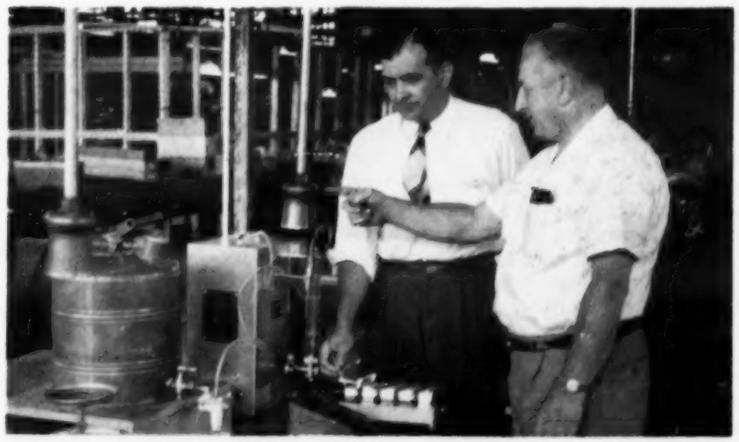
How does the company achieve its high degree of fire safety? R. J. Race, director of Scripto's mechanical division, and R. D. Stock, safety coordinator, adopted this plan:

- To make a thorough survey for specific fire hazards in the plant with the aid of an insurance underwriter (F.I.A.) and the cooperation of the local fire department
- To list hazards and then provide the best suitable portable fire extinguisher for each type of hazard
- To provide plenty of water-type portable extinguishers for areas containing no specific hazards or only ordinary combustibles
- To train employees in the use of the fire-fighting equipment
- Last but not least, to establish personnel evacuation and alarm procedures for all emergencies.

Houston Street plant's fire safety program is typical of the overall company plan. Primary fire safety for the entire building is provided by an automatic water sprinkler system. It is supplied from city mains at 60 psig. Building is divided with self-closing fire doors.

Complementing the sprinkler system is its portable fire extinguisher program. A number of conspicuously marked, strategically placed portable extinguishers can be seen from almost any location in the plant. Scripto generally uses only water-type, carbon dioxide, and dry chemical portables, depending on the type of fire likely to be encountered—water types for ordinary combustibles, carbon dioxide or dry chemical for electric or flammable liquid hazards.

When the plant is shut down, fire-detection responsibility falls to guards who walk watch-clock patrols. Normally no area goes unchecked more than 15 minutes. ♦♦



Filter scrubs itself

A. A. LINGO and **R. F. CUMMINS**
California Electric Power Co.

Problem: Good water is getting harder to find . . . especially in water-short California. And when the building schedule for a new power plant is suddenly telescoped from a 1960 building date back to actual 1956 construction date, water problems are compounded.

That's what happened at California Electric Power Co. In 1952, two steam generators were placed in operation at its Highgrove Station. Next year, population growth was so rapid that the two additional "1960" generators were rushed into reality.

Normally, Highgrove gets most of its water from irrigation canals that serve local citrus groves. This water must cool the turbine condensers at an average total flow rate of around 118,000 gpm, 24 hours a day. On occasions, this water supply contains sewage effluent with suspended solids as high as 30%, but it is usually about 15 to 20 ppm.

Because of the suspended solid load variation, the clean-up operation has to be effective enough to protect the cooling towers and other equipment.

Solution: A single, automatic backwash sand filter cleans up water obtained from outside sources. Cost of this treatment is nominal, yet solids content is reduced from 15 to 20 ppm to around 5 ppm or lower.

Automatic backwash filter is simple in operation — it cleans itself, with no shutdown or change-over, no extra "reserve unit" needed.

Filter consists of a long, horizontal tank with water flowing downward through a compartmented sand bed. Over this bed travels the automatic backwash and cleaning carriage mechanism.

Untreated water overflows into sandbed area from influent channel which runs the entire length of the filter, and discharges to the effluent channels below.

As suspended matter is filtered out onto the surface of the sand, filtering rate decreases, and head in the filter tank builds up.

At a predetermined level, an electrical contact starts backwash carriage moving. Two pumps located on this carriage also start operation. The backwash pump picks up clean water from the effluent channel and pumps it back through the porous bottom of the filter and thence through the sand itself in reverse flow. This is accomplished by dividing the filter bottom into compartments. The sand is held in separate transverse compartments approximately 8 inches wide and 11 inches high. Each of these compartments is washed successively as the backwash carriage travels the length of the bed. Water is forced in reverse through ports in the filter bed wall, entering each compartment just below porous bottom of the compartment. As carriage moves forward, the jet from the backwash pump flushes each compartment successively through a "backwash shoe" which fits tightly against the side wall of the filter bed as carriage moves. This backwash shoe directs the jet stream through the part leading to that compartment.

Backwash water, after washing the sand, is picked up by a "cleaner hood" that fits snugly over the compartment being washed, and travels

(continues on page 48)

Membrane demineralizing

MYRON H. OWENS, Air Control and Warning Station
GEORGE MAHERAS, Ionics, Inc.

A COMPLETELY ELECTRIC demineralizing system provides potable water for 150 to 200 personnel at the Havre, Montana, Air Control and Warning Station near the Canadian border. The comparatively small desalting plant (delivered and installed at a cost of $20,000) was designed and manufactured by Ionics, Incorporated of Cambridge, Mass. It produces 9000 gallons of potable water per day from a deep well source containing 1800 ppm dissolved solids. In operation since June 1956, peak production rate of the demineralizer is still 750 gpd.

Basic principle of electric membrane demineralization is the movement of anions and cations under the influence of a dc potential through special membrane barriers, accomplishing transfer of these ions from one solution to another.

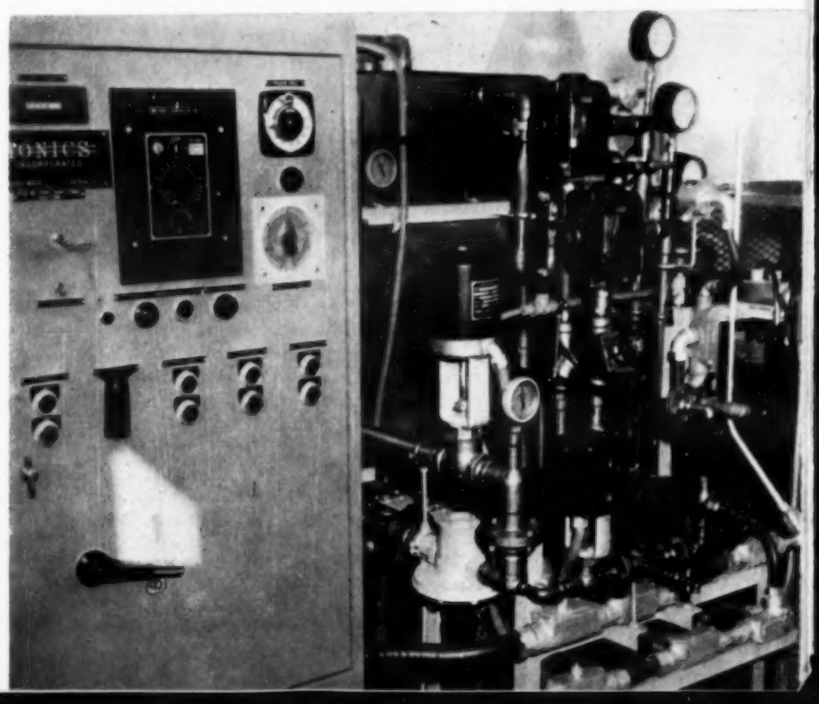
Total power consumption of the demineralizer is 6 kwh/1000 gal of product water. This figure is the summation of the actual pumping energy, dc energy, and energy losses in rectification. Electricity cost at the Air Force installation is unknown, but taking a good industrial average as 1 cent/kwh, energy cost is 6 cents per 1000 gallons of product water.

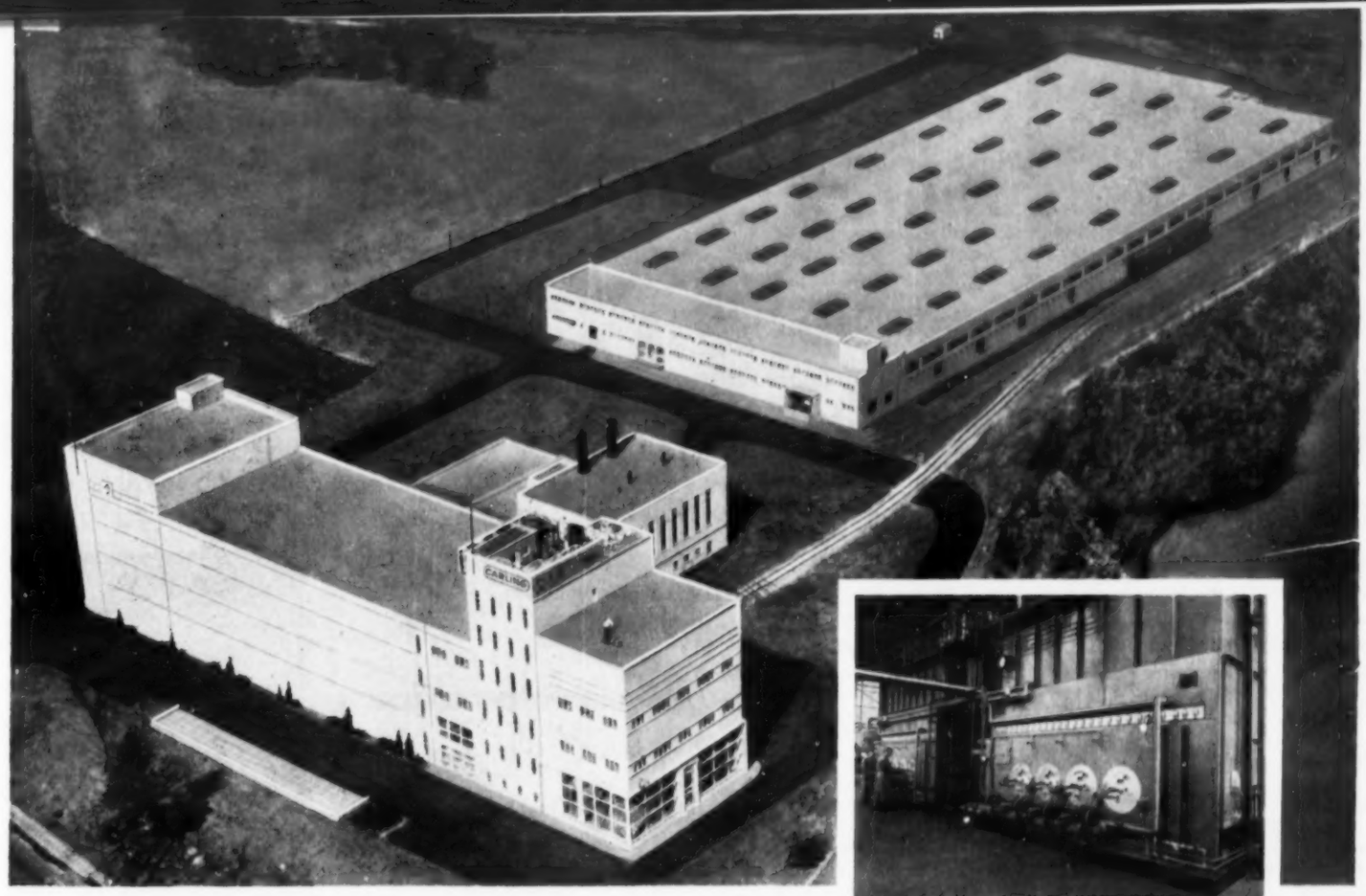
Demineralizer is essentially automatic once it is placed in operation. The startup procedure is comparatively simple, requiring less than five minutes.

Initially, iron sliming of the membranes made it necessary to disassemble and clean the membranes every 10 days. Initiation of controlled chlorination and an increase in feedwater temperature, however, has sufficiently hastened oxidation and precipitation of the iron slime to permit an effective removal of slime at the filtration points of the system. Membrane stack inspection and cleaning is now necessary only after 4 to 6 weeks of operation. The greatest time demand on the water plant operator is backwashing the sand filters and cleaning the feedwater tanks and lines.

Membrane replacement was considered the greatest single cost factor of the demineralizer. The estimate was a replacement rate of one-third per year. No replacement of membranes has been made at the Havre installation during ten months of operation.

Batch-type demineralizers, similar to this installation, are capable of demineralizing waters of any concentration. They are particularly economical and attractive for waters up to the 10,000 ppm range, and competitive for waters ranging in salinity up to that of sea water (35,000 ppm). ♦♦





Each B&W Integral-Furnace Boiler at Carling's Natick plant has a capacity of 58,000 lb of steam per hr at operating pressure of 150 psi and 200 psi design pressure. Plant designed by: Carling Brewing Company, Engineering Department, Cleveland. Architect: John Marshall, Canadian Breweries, Ltd., Toronto. General Contractor: Gilbane Building Co., Providence, R. I.

B&W Integral-Furnace Boilers Prove Reliability at Carling's

TWO UNITS ASSURE CRITICAL TIME CYCLING IN BREWING PROCESS

Carling Brewing Company's Natick, Mass., plant, the first new brewery in New England in more than 40 years, produces 600,000 barrels of Red Cap Ale and Black Label Beer a year. Steam for the brewing process, pasteurizing, sterilizing, and heating the plant is supplied by two B&W Integral-Furnace Boilers.

One Unit Alone is meeting the plant's maximum load of 35,000 lb of steam per hr, with the second on a stand-by basis. This boiler-room schedule is part of the plant's overall design, which will permit adding another 600,000 barrels of capacity when required.

After a Year of Operation, Lewis R. Grant, Chief Engineer, reports that the oil-fired boilers have given instantaneous response to load changes and are operating at high efficiency. There has been no maintenance necessary since the boilers went on the line.

Reliability Is Important at the Natick plant because of the exacting time cycling of the brewing process. The B&W units have easily met this test. The steam delivered has been clean and dry, with no indication of solids carry-over.

B&W Integral-Furnace Boilers, for any steam requirements up to 350,000 lb per hr and for all fuel conditions, incorporate installation, operating, and maintenance features that give greater boiler efficiency, availability, continuity of service, and overall economy. They provide maximum capacity in small space, high fuel economy, smokeless combustion, and economical, fast steaming. Completely integrated units, they are backed by the undivided responsibility of a single manufacturer, with nearly a century of steam generating experience. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-839-18

BABCOCK & WILCOX

BOILER DIVISION

Circle 132 on Reader Service card for more data

POWER BASICS FOR TODAY'S INDUSTRY

Fluid mechanics—III

Working with Bernoulli's theorem

We've all heard of the Roman citizen who used to gyp the city with his water bill by using a short tube from the aqueduct, rather than an orifice of the same diameter. Technology has advanced, but the principles are the same as ever. Perhaps you could get more for your money if you brushed up on fluid mechanics basics.

PROFESSOR JAMES M. ROBERTSON
Theoretical and Applied Mechanics
University of Illinois

THE MOST VALUABLE single relationship in fluid mechanics is Bernoulli's theorem. Hardly a problem occurs that does not require its use. We have noted that it states an equality of the sum of potential and kinetic energies through a flow process involving no work or losses. The generalized expression for Bernoulli's theorem, including work done on the fluid (per pound of fluid flowing) E_w and head loss h_L, is written

$$\frac{p_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} + E_w = \frac{p_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} + h_L \qquad (1)$$

In this form, the theorem states that initial energy per pound of fluid flowing (first three terms), plus work done on the fluid by a machine, equals final energy plus any losses that have occurred.

Flow is from point 1 to point 2 and the signs for E_w and h_L are such that E_w represents the energy added (per pound of fluid flowing) and h_L is treated as a positive quantity. Since friction losses are always computed as positive quantities, Eq. 1 is an irreversible equation. Flow must be from 1 to 2. Should the problem be one in which the flow direction is unknown, the only approach is to assume the flow direction and proceed with the solution. If this indicates that the flow is actually the other way, then the problem must be resolved for flow in the opposite direction. If we have a turbine or motor between points 1 and 2, then the sign of E_w is minus. It is possible to have a machine that may act either as a pump or a turbine. In such a case, the only sure way to ascertain which it is, is from the sign of E_w.

Application of Bernoulli's theorem, when coupled with methods for estimating friction and other losses in pipeline flow, enables us to estimate the pump size required to circulate fluids through pipelines and to determine pressures at various points in the line. If a pipeline follows the ground contour, it may contain high points where the pressure is much lower than at the end of the line. If the pressure at these points is close to vapor pressure, troubles such as cavitation can occur.

EXAMPLE: In a power plant cooling system, water is being pumped through a 72-in. pipeline at 300 ft³/sec. At a point 480 feet from the discharge point, the pipe passes over a levee with 169-ft elevation. Water discharges into a reservoir whose surface elevation is 149 feet. To assess the possibility of cavitation, we must first determine the pressure in the high point of the line.

SOLUTION: From continuity, the flow velocity is

$$V = \frac{Q}{A} = \frac{300}{28.3} = 10.6 \text{ ft/sec},$$

$$\text{hence } \frac{V^2}{2g} = 1.74 \text{ feet}$$

An estimate of friction in the 480 feet of pipe indicates a loss of about 2.5 feet. Writing Bernoulli's theorem between the top of the pipe, where it passes over the levee, and a point in the reservoir at the pipe exit, we have

$$\frac{p_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} + h_L$$

$$\frac{p_1}{\gamma} + 175 + 1.74 = 0 + 149 + 1.74 + 2.5$$

$$\frac{p_1}{\gamma} = -23.5 \text{ feet gage}$$

$$\text{or } p_1 = -10.2 \text{ psig}$$

This is an absolute pressure of about 4.5 psia. If the water were at 160 F (for which the vapor pressure is about 4.7 psia), cavitation or boiling would occur at the high point, reducing pipe capacity.

proper choice of end points aids solutions

In solving problems with Bernoulli's theorem, we often appear to have considerable latitude in choosing our end points 1 and 2. If we are not careful which points are chosen, it will turn out that the equation will have to be written several times between different points to obtain the desired information. Sometimes this is necessary, but not always. In general, points 1 and 2 should be chosen as far apart as possible, and they should be points for which as many energy terms as possible are known.

EXAMPLE: A water turbine at elevation 80 feet is connected to a reservoir (surface elevation 100 feet) by a 100-ft long 6-in. dia steel pipe with a well rounded entrance. Turbine discharges to atmosphere through an 8-in. dia pipe at elevation 75 feet. What is the turbine horsepower developed for a discharge of 2.0 ft³/sec?

SOLUTION: The arrangement of the reservoir, pipe, turbine, and discharge is shown in Fig. 1. From the rate of flow, material, and size of the pipeline, head loss through the pipe is found to be 6.4 feet.

Several possibilities exist for points 1 and 2 in applying Bernoulli's theorem. These possibilities are indicated as points A,B,C, D, and E. Following the suggestion that the points be as far apart as possible, consistant with being able to utilize them, we try points A and E for 1 and 2 in Eq. 1. Inspection of flow conditions indicates that all energy terms are

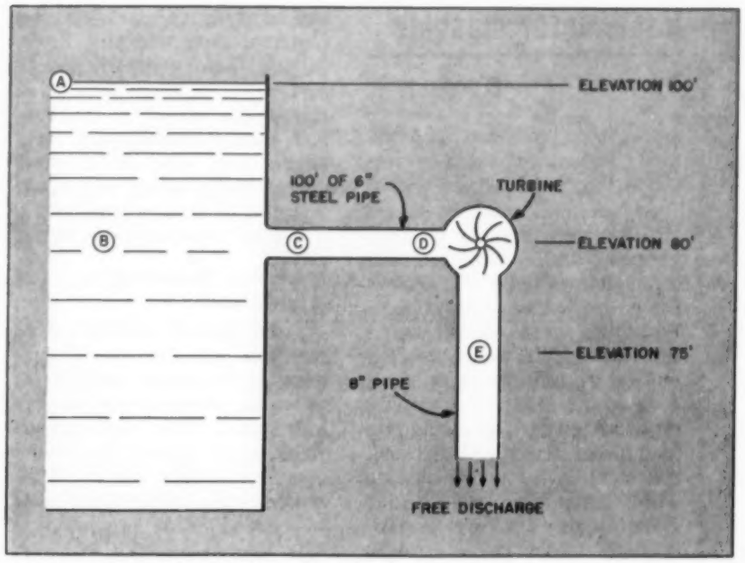


Fig. 1—Schematic of turbine developing power from water flow from reservoir. Choosing proper end points helps when using Bernoulli's theorem.

known at both the points selected.

$$\frac{p_A}{\gamma} + Z_A + \frac{V_A^2}{2g} + E_w = \frac{p_E}{\gamma} + Z_E + \frac{V_E^2}{2g} + h_L$$

$$0 + 100 + 0 + E_w = 0 + 75 + \frac{V_E^2}{2g} + 6.4$$

The advantages of choosing point A are obvious. The elevation is known, pressure is zero gage, and water velocity is zero, since the reservoir is of appreciable size. At point E, we know the elevation and can find the velocity ($V_E = \frac{2.0}{0.35} = 5.73$ fps) and velocity head $\left(\frac{V_E^2}{2g} = 0.51 \text{ ft}\right)$. The pressure here is zero gage, or atmospheric, since the flow is discharging to atmosphere without contraction or expansion. Our equation becomes

$$0 + 100 + 0 + E_w = 0 + 75 + 0.51 + 6.4$$

$$E_w = 81.91 - 100 = -18.09 \text{ ft.}$$

The sign on E_w is negative, indicating that the machine is indeed acting as a turbine and is taking power out of the flow. Power is found from the product of head E_w in foot pounds per pound of fluid flowing, and the weight rate of flow.

$$\text{Power} = Q\,\gamma\,E_w = 2.0 \times 62.4 \times 18.09 = 2258 \text{ ft lb/sec}$$

or, dividing by 550 ft lb/sec, = 41 hp.

Such a machine is not 100% efficient, so turbine shaft horsepower is appreciably less.

Point B could have been used for 1 in this solution, as long as it is far enough from the pipe entrance. In that case, $\frac{p}{\gamma}$ would have been 20 feet and Z would have been 80 feet and the initial energy still would have been 100 feet. If points C or D had been used for point 2, we would have determined the pressure in the pipe at these points. This might be worth knowing, but it would not give us the turbine power.

Ignoration of friction and losses is sometimes possible

In all examples we have considered so far, it has appeared necessary to estimate head losses to obtain a reasonably accurate solution. It is not always necessary to include friction. In the cooling-water system example above, if the levee had been only 48 feet from the point of discharge into the reservoir, the friction loss would have been only 0.25 feet. Since this is about 1% of the answer, it is negligible. This suggests that when two points are close together, the losses between them may be neglected in applying Bernoulli's theorem, which we then express in the basic form

$$\frac{p_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} \quad (2)$$

But the situation is not always so simple. In certain cases, appreciable energy losses occur in relatively short distances. In an expansion, whether it be a diffuser or a sudden increase in pipe diameter, quite large head losses occur in only a few pipe diameters. Further consideration of the loss question indicates that if deceleration in flow near a surface occurs, losses arise which may not be ignored. On the other hand, if a fluid is being accelerated, the losses are so small as to be usually negligible.

There are numerous applications in which we may use the simple theorem and ignore the losses. This naturally simplifies the problem. A common example of this type is flow occuring in a fluid flow measuring instrument. In fact, one reason for choosing many of our common types of fluid flow instruments is that frictional effects within them are so small that the discharge relationships are definitely known and there is little variation with Reynolds number. Consider, for example, our usual device for velocity measurement – the Pitot tube (Fig. 2). In this device, flow is decelerated in front of it and there is no opportunity for friction or losses to occur. With zero velocity at the front of the tube, where the stagnation opening is, proper measurement of the undisturbed pressure (not always an easy thing) yields us a relationship for the velocity. If point O is an upstream point in the undisturbed fluid, point S is the stagnation point (zero velocity) at the front of the tube, and the streamline between the points is horizontal,

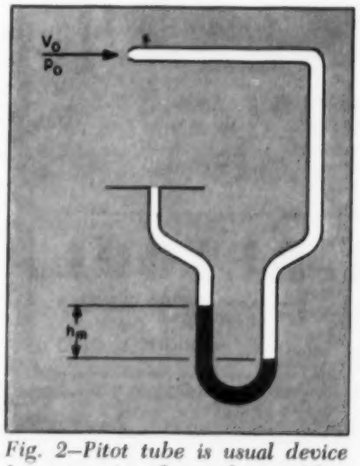


Fig. 2—Pitot tube is usual device for measuring flow velocity. Flow is decelerated in front of tube.

we have from Eq. 2, the formula

$$\frac{p_o}{\gamma} + Z_o + \frac{V_o^2}{2g} = \frac{p_s}{\gamma} + Z_s + \frac{V_s^2}{2g}$$

$$\frac{p_o}{\gamma} + \frac{V_o^2}{2g} = \frac{p_s}{\gamma}$$

the basic Pitot tube relation is therefore

$$V_o = \sqrt{\frac{2g(p_s - p_o)}{\gamma}}$$

In utilizing this equation for a Pitot tube we often put a co-efficient in front of the right side to account for difficulties in measuring p_o, our undisturbed reference pressure. Analysis of flow at the stagnation point deviates from what we have assumed only at very low velocities (Pitot tube Reynolds numbers of about one and less) when the effect of viscosity greatly modifies the stagnation point flow.

Our most common types of flow rate meters, the orifice meter, Venturi meter, or flow nozzle (Fig. 3), represent simple applications of Bernoulli's theorem to cases of negligible losses. Flow through any contracting device causes a pressure difference that is directly related to flow rate. Let point 1 represent the pipe cross section upstream from the constriction and point 2 represent the throat of the device. For proper application of Bernoulli's theorem in the case of the orifice meter, we should consider that the flow, after passing through the orifice plate hole, contracts to a smaller diameter. Unfortunately, we do not know what this diameter is and we can't predict it. We must treat the flow as though the downstream cross section is given by the orifice opening. We then correct for this approximation with the aid of an empirical coefficient. For all three cases, therefore, we express the continuity relation as

$$Q = A_1V_1 = A_2V_2$$

Inserting this relationship between V_1 and V_2 into Eq. 2, solving for V_2 and thus for the rate of flow Q, we obtain the basic metering equation

$$Q = \frac{CA_2}{\sqrt{1 - (A_2/A_1)^2}} \times \sqrt{2g\left(\frac{p_1}{\gamma} + Z_1 - \frac{p_2}{\gamma} - Z_2\right)} \quad (3)$$

Coefficient C is added to allow for the fact that in the Venturi and

(continues on page 30)

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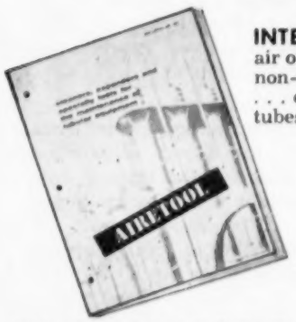

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More motor muscles

. . . starts on page 14

to ten seconds delay, and the total current should not rise above the initial value.

As noted, a standard motor starting on two-thirds winding normally has a smaller torque dip and less noise than when using the half-winding connection. Also, current inrush should be much smaller when the second contactor is closed. This reduces the peak forces on motor end windings and should prolong life in service with frequent starting. Current density in windings and current in each contactor pole are lower in starting, reducing coil heating and contactor duty to about three-fourths that of the half-winding connection. If there is a delay closing the second contactor, both motor windings and contactors may seriously overheat during half-winding starting. The risk of serious overheating is less on two-thirds winding

smoother acceleration is obtained

Motor acceleration will be smoother on the two-thirds winding connection because accelerating torque is sustained to full speed. The usual torque shock upon closing the second contactor at slow speed (as required in the half-winding case) is avoided. This provides *soft*

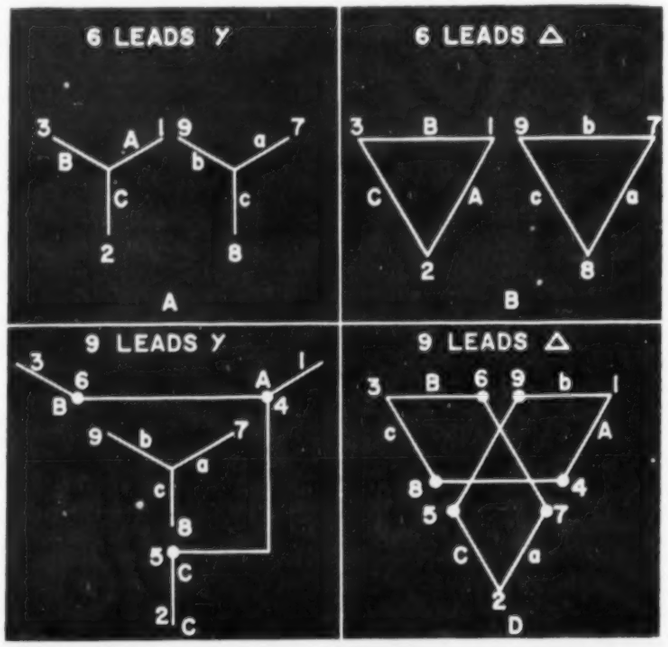

Fig. 3—Motors with any of these internal connections can be used with the new part-winding arrangement to give better starting

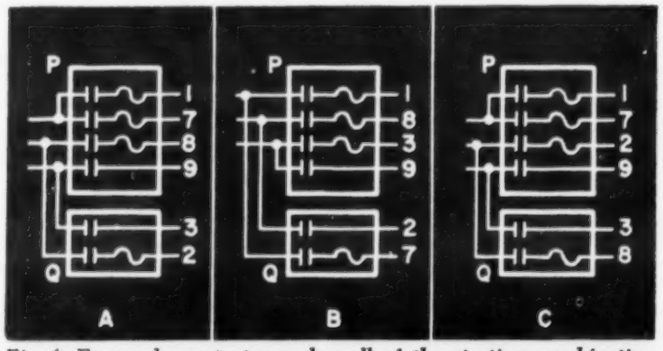

Fig 4—Four-pole contactor makes all of the starting combinations listed in Table I possible. Better starting performance is the result.

TABLE I

ALTERNATIVE PART WINDING STARTING METHODS

Methods	Six lead motors Winding	Six lead motors Connections	Nine lead motors Winding	Nine lead motors Connections
Two-Step Starting				
1/2 Y	Fig. 4A	Fig. 5A	Fig. 4C	Fig. 5A
1/2 delta	Fig. 4B	Fig. 5A	Fig. 4D	Fig. 5C
2/3 Y	Fig. 4A	Fig. 5B	Fig. 4C	Fig. 5B
2/3 delta	Fig. 4B	Fig. 5B	Fig. 4D	Fig. 5A
Three-Step Starting				
2/3 Y and 5/6 Y	Fig. 4A	Fig. 6A	Fig. 4C	Fig. 6A
1/2 delta and 5/6 delta	Fig. 4D	Fig. 6B	Fig. 4D	Fig. 6B

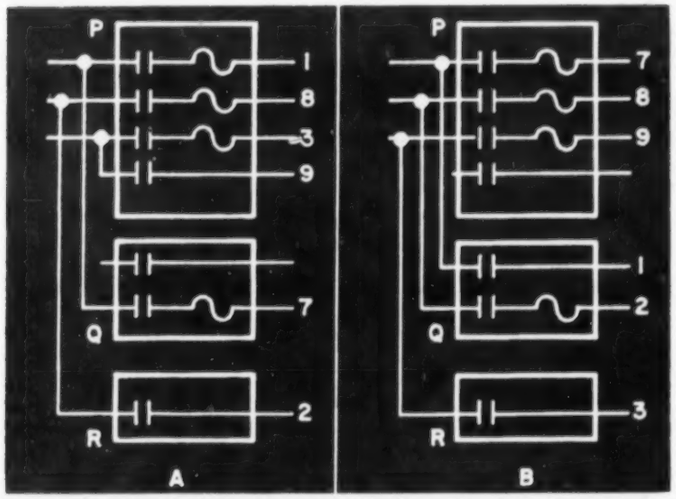

Fig. 5—An extra single-pole contactor allows three-step part-winding starting. This is shown in detail in the list included in Table 1.

starting, which is often desired to lighten duty on gears and other mechanical parts.

panel versatility handles delta motors, too

New panel provides for either half or two-thirds starting of delta connected motors with the same performance as obtained with Y-connected motors. The conventional panel with two similar three-pole contactors does not permit starting nine-lead delta-connected (dual-voltage) motors. Wiring necessary to connect the proper set of coils to the first or starting contactor will force it to carry about 2½ times as much current as the other contactor *during running conditions*. To avoid the need for a larger contactor, dual-voltage motors for part-winding starting have been provided with Y windings. With the new arrangement, having one four-pole and one two-pole contactor, a delta-wound, dual-voltage motor for part-winding starting is connected (Fig. 3D and Fig. 4A or 4C), so that each contactor pole carries the same current. Hence, the same half-rated contactors provide for delta- as well as for Y-connected motors.

This is a material advantage

(continues on page 28)

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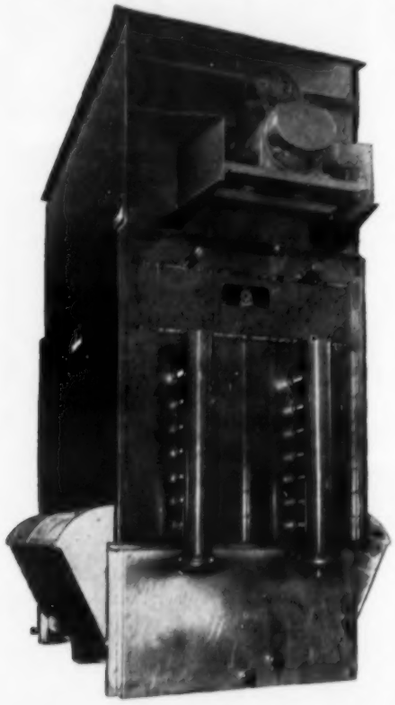

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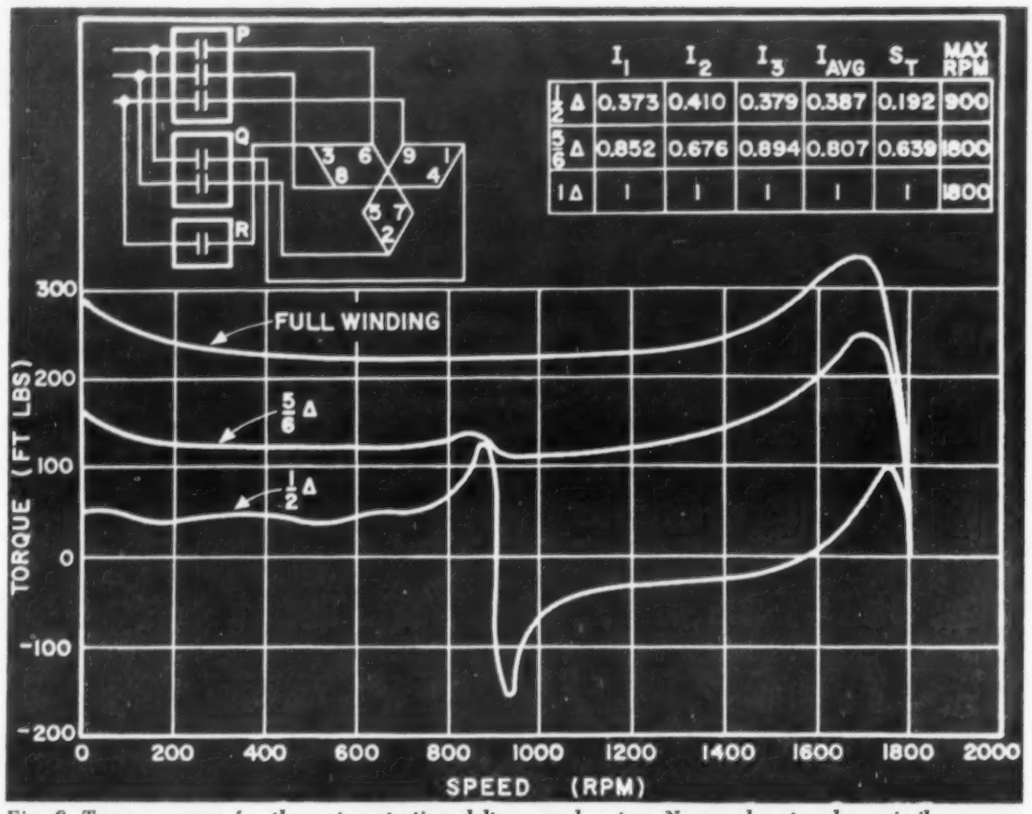

Fig. 6—Torque curves for three-step starting delta-wound motors. Y-wound motors have similar curves.

because inherent design features make delta windings preferable for many motors, especially in the larger sizes. The extra costs and delays in providing special motors and panels, or in warping designs to permit part-winding starting, are avoided.

Improved performance on reduced-current starting with part windings can be obtained with a panel having three half-current contactors. It may be the same as the arrangement already described except for a third contactor (Fig. 5), which may have only one pole. Connection details are given in Table I and characteristics for a delta-wound motor in Fig. 6.

Briefly, the first step in starting a delta-wound motor connects the windings in three open half-delta circuits which draw only 40% as much current as if the motor were thrown directly across the line. Torque is very low so that this merely serves as a means of obtaining a low initial current increment.

starting sequence prevents current inrush

On the second step, after two or three seconds, contactor Q is closed, bringing five-sixths of the total winding into use. Motor current increases to about 80% of maximum and motor develops about two-thirds maximum torque, coming to full speed promptly. Third contactor, R, is then closed.

Similar performance can be obtained with a Y winding. In this case, the first step uses the two-thirds connection, drawing about 65% current, and the second step the five-sixths connection with 80% current as in the delta case. Still better performance and smoother starting is obtained, at extra cost, with a resistor on the first and/or second step. It is shorted out on the final step by one of the otherwise idle contactor poles. ♦♦

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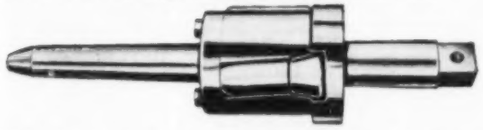

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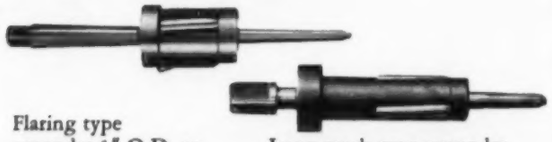

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Eliminate windows

. . . starts on page 18

fered with operators trying to see the turbine room instrument panel. Operators, facing west toward instruments, could not see with sun shining in their eyes.

All these factors pointed toward replacing the glazed rack-and-pinion sash with an opaque, insulated, fixed covering that would eliminate the principal problem of high maintenance.

H. H. Robertson Co. furnished their MG Type Q panels for the six openings in the turbine room west wall. Five openings are 14 ft 6 in. wide by 34 feet high. A sixth opening is 8 ft 6 in. wide by 34 feet high. Panel sections are 2 feet wide and full length to eliminate all end joints. Outer panel sheet is 16 gauge Alumilited aluminum with a special diamond pattern in the surface. Inner sheet is 18 gauge metallic-coated steel. Between the two sheets is a Fiberglas blanket 1½ inches thick. All joints are caulked. External and internal flashing are the same material as the abutting panel sheet.

removable window panel for equipment replacement

The contractor removed and hauled to General Electric's disposal area the existing sash and operating mechanisms. Contractor then installed panels furnished by Robertson. All window openings except one were closed by welding the inner panel sheets to existing window girt angles. Panels for one large window are screwed on so that equipment can be moved in and out of the power house through the opening at some future time. Exterior sections are fastened with stainless steel fasteners. Interior panel surfaces were left unpainted by the contractor, and subsequently painted light green to match structural steel in the turbine room.

For $3/sq ft (including removal and disposition of old sash), the turbine room west wall now has a tight and dry closure. This job will pay out in 5 years in terms of the maintenance it has eliminated . . . the principal reason for doing the job. In addition, switchgear is no longer in peril of leaking water. Operators can work at the turbine room control board without squinting against the afternoon sun. Insulation in the panels keeps the turbine room cooler in summer and reduces heat loss in winter. ♦ ♦

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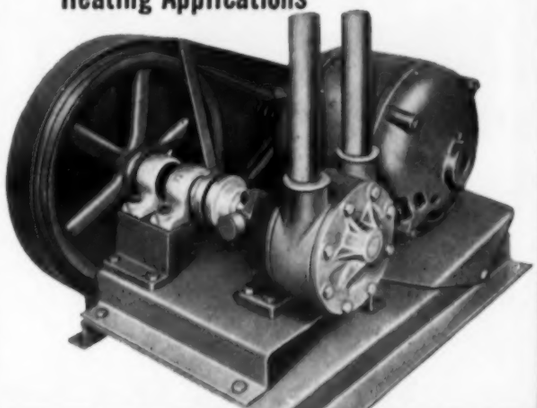

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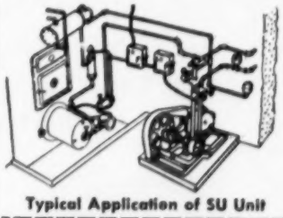

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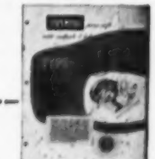

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Fluid mechanics

. . . starts on page 24

nozzle a_1 is not zero and there are some small frictional effects. C is therefore about 0.98 in these cases. In the orifice meter, the coefficient also has to take into account the fact that the proper flow area to use at point 2 is less than the orifice area. In this case, C is more a coefficient of contraction and has a value of about 0.60.

As shown in Fig. 3, pressure difference across a flowmeter is usually indicated by a U-tube or differential manometer. In such a case, the manometer indication h gives us the bracketed term following 2g in Eq. 3, and we may write Eq. 3 as

$$Q = \frac{CA_2}{\sqrt{1-(A_2/A_1)^2}} \sqrt{2gh} \quad (3a$$

The relationship between Q and h is thus independent of inclination of the pipeline to which the flowmeter is connected.

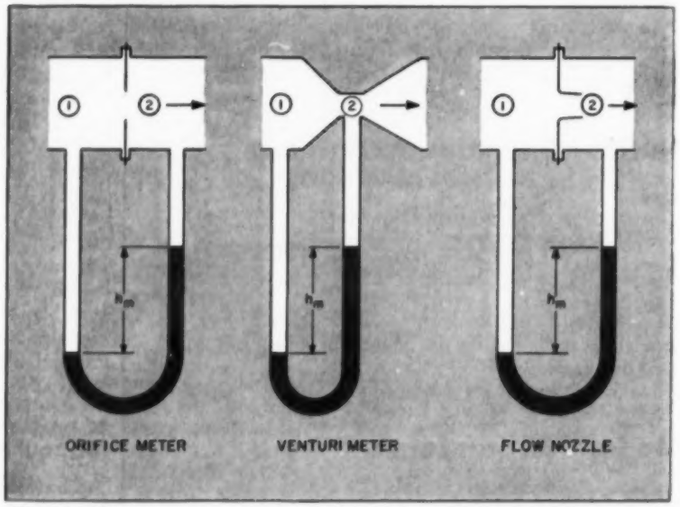

Fig. 3—Most common types of flow rate meters represent simple applications of Bernoulli's theorem to cases of negligible losses

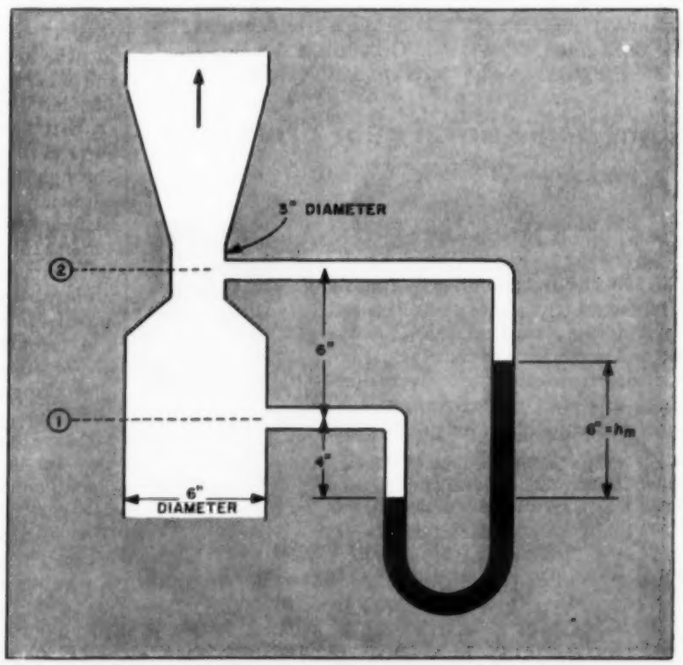

Fig. 4—Schematic of Venturi meter connected to water-mercury manometer for determining rate of flow in vertical water pipe.

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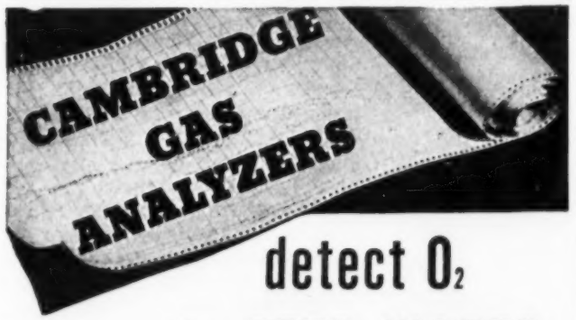

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EXAMPLE: A vertical 6- by 3-in. Venturi meter, located in a water line, is connected to a water-mercury manometer. This manometer indicates a difference of 6 inches (h_m) and is connected to the Venturi at points separated vertically by 6 inches as shown in Fig. 4. What is the rate of flow?

SOLUTION: From a preliminary solution of the problem, we can estimate the discharge coefficient for the Venturi as C = 0.983. The first step is to write the manometer equation between pipe and throat connections to the flowmeter. Taking the specific gravity of mercury as 13.6, we can say

$$p_1 + \frac{4}{12} \times 62.4 - \frac{6}{12} \times 13.6 \times 62.4 - \frac{4}{12} \times 62.4 = p_2$$

The pressure difference from the above notation is

$$\frac{p_1 - p_2}{\gamma} = \frac{p_1 - p_2}{62.4} = \frac{6}{12} \times 13.6$$

For insertion into Eq. 3, we need the difference between the pressure plus elevation terms. This is therefore:

$$\frac{p_1 - p_2}{\gamma} + Z_1 - Z_2 = \frac{6}{12}(13.6 - 1) = h$$

This is a unique function of h_m and the gage fluid and is independent of Z_1 and Z_2. The velocity of approach term $(1 - (A_2/A_1)^2)$ is calculated from the dimensions of the Venturi as 0.9375. Inserting these values into Eq. 3 we have

$$Q = \frac{0.983 \times 0.0491}{\sqrt{0.9375}} \sqrt{2g\frac{12.6}{2}}$$

$$= 1.00 \text{ ft}^3/\text{sec}$$

For the differential indicated by the manometer (6 in. hg), the flow would be the same if the meter had been located horizontally or at any other slope. This simple and convenient situation holds as long as the pressure difference is indicated by a differential manometer, and the pipe fluid is continuous through manometer lines.

Perhaps the simplest case in which friction may be ignored is exemplified by Torricelli's theorem. This relationship for the velocity of discharge of a liquid through an orifice in the side of a large tank,

$$V = \sqrt{2gh}$$

(continues on page 32)

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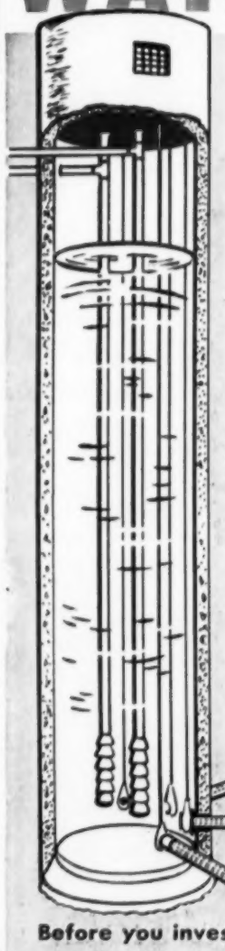

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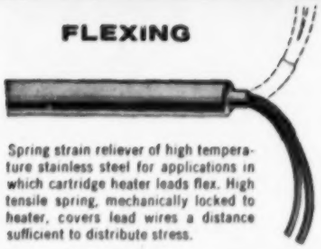

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was found some time before the general relation of Bernoulli was propounded. Rate of discharge (Q) is found by multiplying the product of this velocity and the orifice area by a coefficient (about 0.61), which allows or corrects for the contraction of the jet as it flows through the opening. Because the contraction is eliminated, the discharge from a short tube is greater than from an orifice of the same size even though losses are significant.

Another simple yet useful application of Bernoulli's theorem is in evaluating pressure variation in certain flow situations from known velocity distributions. It is often possible to determine velocity by analytical or graphical methods. But, we are most interested in the pressures. If the fluid is a gas or if the elevation changes are insignificant, we may write Eq. 2 as

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + \frac{V_2^2}{2g}$$

Solving this for the pressure variation referred to conditions at point 1, we have,

$$\frac{\frac{p_2 - p_1}{\gamma}}{\frac{V_1^2}{2g}} = 1 - \left(\frac{V_2}{V_1}\right)^2$$

This equation tells us, for example, that at the exit from a 3:1 plane contraction, pressure head is reduced by eight velocity heads, since velocity is increased to three times the entering value.

correction for nonuniform velocity

In the flow of almost any fluid through a conduit, the effect of friction causes velocity to vary across the conduit. The mean flow velocity, given by

$$V = \frac{Q}{A}$$

occurs at only a few places in the conduit cross section. Since the terms in Bernoulli's theorem are considered to indicate specific energies (kinetic or potential), this says that $\frac{V^2}{2g}$ does not accurately represent the true kinetic energy of the flow. This divergence from our usual simple assumption is sometimes significant. To allow for this effect, we replace $\frac{V^2}{2g}$ by $\frac{\alpha V^2}{2g}$, where α is greater than one and is termed the kinetic energy factor or correction factor.

what is kinetic energy factor?

The kinetic energy factor represents the summation across our flow system of the kinetic energy flux carried by each streamtube. For developed flow in pipes, we have several presentations of the relationship between α and the factors affecting pipe flow (roughness and Reynolds number). For laminar flow $\alpha = 2.0$; for turbulent flow, a simple relation presented by Moody in 1950, $\alpha = 1 + 2.7f$ where f is the conventional friction factor. This friction factor varies with pipe wall roughness and nature of flow in the conduit (as indicated by the Reynolds number). In many pipes, f is about 0.02 and thus α is about 1.05. The size of our correction (5%) to the $\frac{V^2}{2g}$ term indicates why we usually treat this factor as unity. Of course, the correction for laminar flow is significant, but the majority of our problems involve turbulent flow.

For non-circular conduits, the value of α is generally less than those indicated. For instance, in a very wide rectangular duct in laminar flow, the value is 1.54 and for turbulent flow α has a value about 80% of the circular conduit value. These relationships for our correction factor α are for fully developed flow in pipes and conduits. This is found to occur only at some distance from flow disturbances such as expansions, bends, valves, etc. If we wish to apply Bernoulli's theorem with much precision near such devices, we need to know the velocity profile in considerable detail so that α can be accurately evaluated. In flow expansions, for instance, values of the kinetic energy factor greater than 2 have been observed with turbulent flow. This correction factor, therefore, can be significant. In some cases, such as following a partly closed gate valve, the flow is so disturbed, containing areas of reversed flow, that one cannot evaluate α.

When the flow is accelerated, as in the contracting portion of a Venturi meter, the velocity distribution becomes very uniform and α is close to unity.

Considering Bernoulli's theorem and energy in fluid flows often leads one to the concept of efficiency. The suitability of flow devices may be assessed in terms of this factor. Devices often operate to convert one form of energy into another,

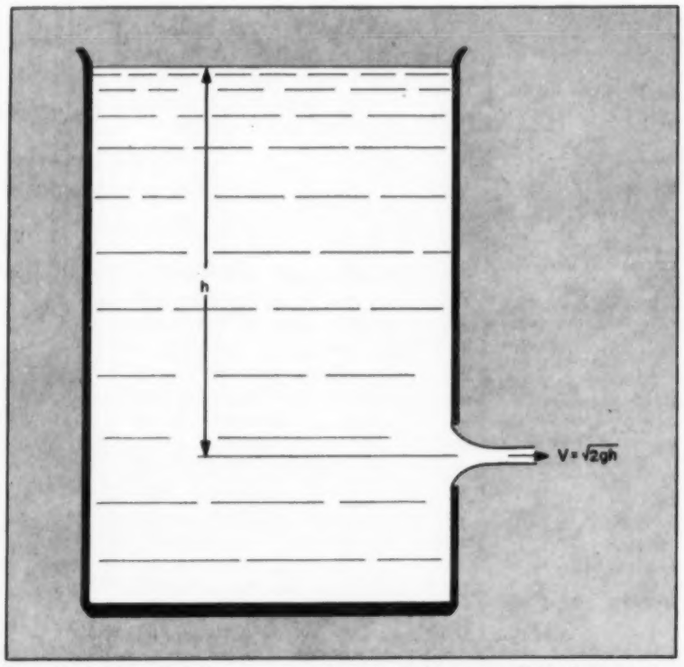

Fig. 5—Liquid flow from an orifice in tank. Torricelli's theorem ignores losses from friction. Discharge rate allows for contraction.

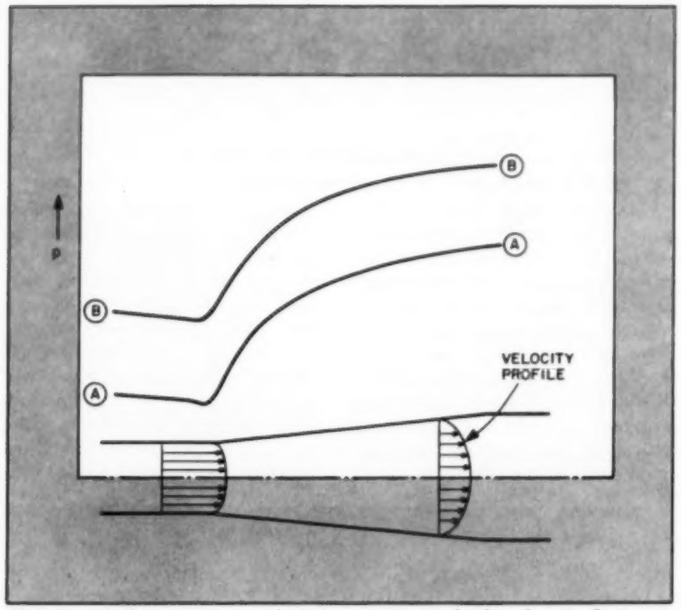

Fig. 6 — Diffuser converts kinetic energy of high-velocity flow into pressure energy. Action is independent of pressure level in conduit.

and efficiency may be defined as a ratio of output to input energy. Since energy is the amount of work a body can do, we often evaluate efficiency in terms of power, the rate of doing work.

EXAMPLE: A pump is moving 3 ft³/sec of water against a head of 100 feet. The pump is being driven at a speed of 1700 rpm with a shaft torque of 750 ft lbs. What is the efficiency of the pump in converting mechanical into flow energy?

SOLUTION:

$$\text{Efficiency} = \frac{\text{power output}}{\text{power input}}$$

$$= \frac{3 \times 62.4 \times 100}{750 \times 1700/60}$$

$$= \frac{18720}{21300} = 0.88$$

or 88%

The difference between input and output in this case can only be due to mechanical and fluid friction losses and to leakage losses in the pump.

Application of the efficiency concept to fluid elements is conveniently expressed with the aid of the specific energy terms of Bernoulli's theorem. This is particularly so when concerned with a device such as a nozzle or diffuser, in which one form of fluid energy is being changed into another. Using the specific energy terms, such as appear in Eqs. 1 and 2, unfortunately does not always lead to unequivocal results. In the case of conduit flow, pressure level in the conduit has no effect on flow element efficiency. Absolute values of p_1 and p_2 are not important, only the difference matters.

A diffuser, for example, has as its function the conversion of the kinetic energy of high-velocity flow into pressure energy. The action of the diffuser—the nature of the flow in it—is not changed as the pressure level is raised or lowered. Thus, in Fig. 6, action of the diffuser does not vary as pressure level is increased from A to B. In a closed conduit, therefore, the pressure term in Bernoulli's theorem does not necessarily represent an energy—a capacity to do work. Definition of efficiency in such a case involves only pressure increase $p_2 - p_1$ and kinetic energy $\alpha \frac{V^2}{2g}$. ♦♦

Next month, Professor Robertson will continue this series on fluid mechanics with a discussion of Viscosity: its effect on fluid flow. As usual, numerous examples will be given, with solutions. This series, like others in POWER INDUSTRY'S *Power Basics for Today's Industry, will be reprinted in booklet form when complete.*

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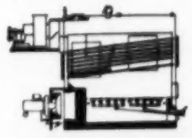

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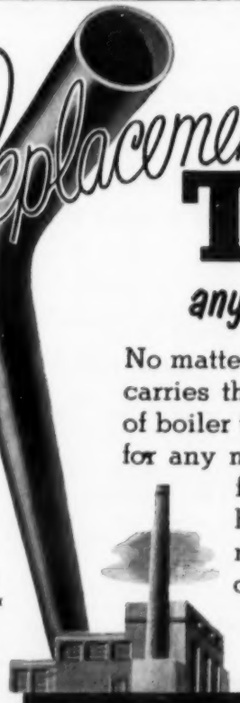

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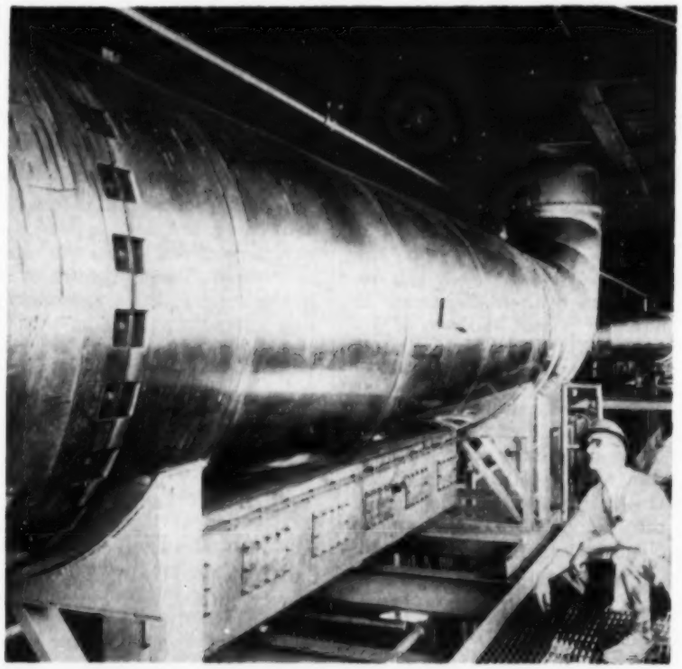

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702-Replace seat fast in butterfly valves

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703-Spray protects stockpile outdoors

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704-Circuit transformers have low noise level

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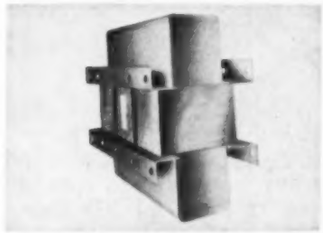

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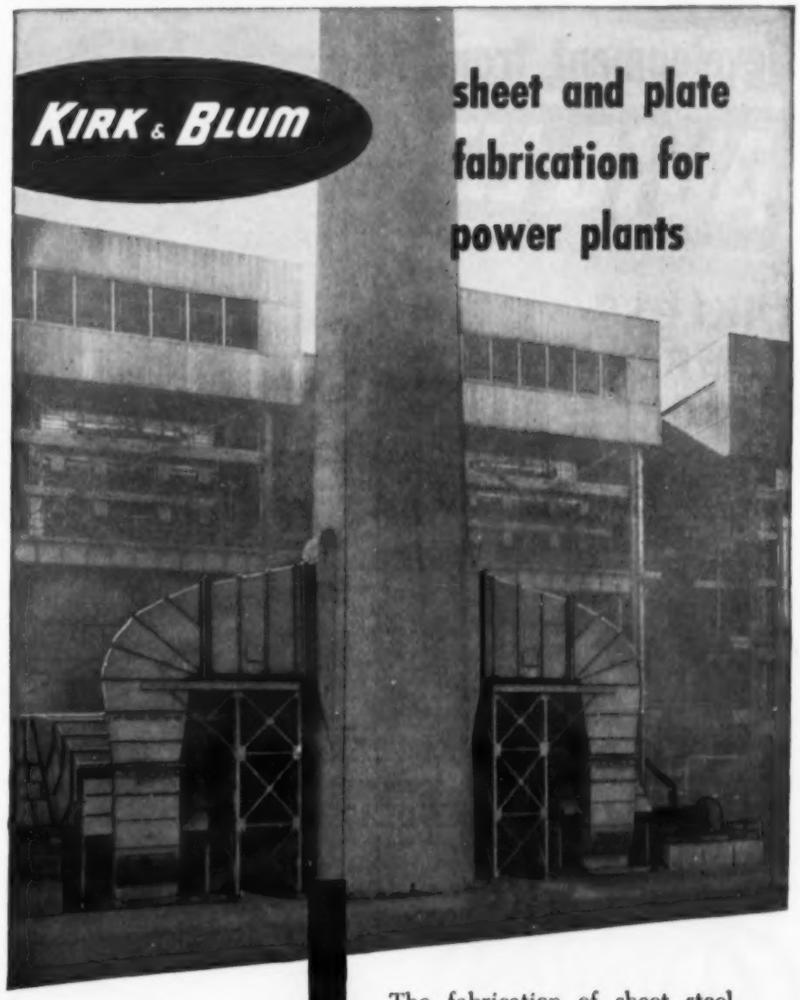
(continues on page 36)



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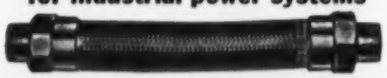

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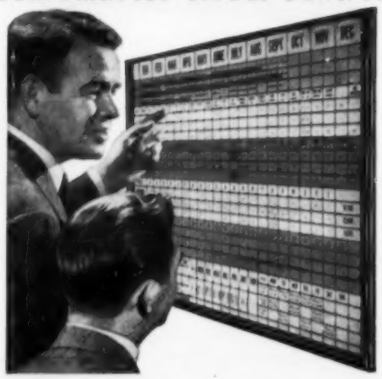

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P new developments
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Scam sequential annunciator systems provide an audible and flashing visual signal on the first alarm to enable the operator of your control board to determine which point in the monitored process first becomes abnormal . . . successive alarms that develop from the original abnormal condition are indicated by a steady visual signal. You can take proper corrective measures immediately because you know where the trouble started.

Shown here is a typical standardized Scam DE-LINE cabinet with integral flasher and reset pushbutton, featuring all the Scam advantages including simple, compact plug-in design.

If you've a process or system that needs automatic, fail-safe, low cost monitoring write us for literature or call the nearest representative in the cities listed below.

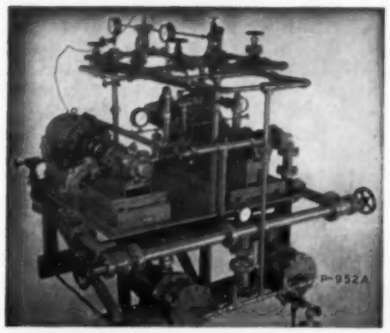
THE SCAM INSTRUMENT CORP.
Chicago 13, Illinois
Phone GRaceland 7-7850

SALES REPRESENTATIVES
Atlanta • Boston • Buffalo • Chicago Cincinnati • Cleveland • Dallas • Denver Detroit • Houston • Indianapolis • Kansas City Los Angeles • Louisville • Minneapolis New Haven • New York • Philadelphia Phoenix • Pittsburgh • Portland • St. Louis San Francisco • Seattle • Tulsa • Toronto and Vancouver, Canada

Circle 128 on Reader Service Card

COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER . .



P-952-A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1350 E. Sedgley Avenue, Philadelphia 34, Pa.
Southwestern Division:
2512 South Boulevard, Houston 6, Texas

Circle 149 on Reader Service card

P/I new developments

. . . starts on page 34

708-Transformers for 10 to 100 kva

Fully protected distribution transformers (Types FCP and FSP) have internal circuit breakers, internally mounted

primary fuses, warning signal lamp, and emergency overload device. When lever is moved to maximum position, warning lamp and breaker settings are advanced to permit nominal overloading. Moving lever to reset position disconnects warning lamp and closes breaker. Excessive overload condition automatically recycles protective devices when lever is held in "on" position. FEDERAL PACIFIC ELECTRIC CO.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a Reader Service card between pages 42 and 43.

709-Control center for ac motors

Class 11-350 control center for ac motor groups houses controls for 3-phase ac systems at 220 volts (1 to 100 hp) and 600 volts (1-200 hp). Controls are centralized in one group of stationary, interchangeable enclosures, each with a grouping of modular starter units. Enclosures may be combined in straight-line, U-, or L-shaped assemblies. Controls may be front or back-to-back mounted in NEMA 1 indoor or NEMA 3 outdoor weather-resistant enclosures. Plug-in stabs are provided on the rear of each draw-out starter unit for connection to vertical bus. WESTINGHOUSE ELECTRIC CORP. ♦ ♦

COCHRANE . . . FIRST IN WATER CONDITIONING

THE PERFORMANCE RECORD *Speaks* FOR ITSELF!

Cochrane CBA Condensate Drainage Control Pump

There are hundreds of case histories to prove the amazing benefits Process Industries derive from the Cochrane C-B System. The effectiveness of this system for improving heat transfer from steam is almost unbelievable!

For example:

- Unit installed on a paper machine saves 20 tons of coal a day while increasing machine drum surface temperature from 260° F to 310° F!
- Canner increased production of jacketed kettles 50%!
- Candy manufacturer doubled its plant production!
- Corrugating plant increased output of double-wall board 61%!
- Recovery plant eliminated the need for one of its two boilers!
- Chemical plant increased drying speed of drum dryer 44% with no wet spots, while increasing boiler capacity and saving $200 a month on fuel!

The Cochrane C-B System assures fast, uniform heat transfer. Condensate can be returned to boiler or make-up system at process temperature, resulting in higher efficiency, increased production and lower steam costs.

For complete details, write today for Publication 6025.

Cochrane

CORPORATION
3108 N. 17TH STREET, PHILADELPHIA 32, PENNA.
NEW YORK • PHILADELPHIA • CHICAGO
Cochrane Water Conditioning Ltd., Toronto 4; Montreal 1, Canada
Representatives in 30 principal cities in U.S.A.

Demineralizers • Zeolite Softeners • Hot Process Softeners • Hot Lime Zeolite Softeners
Dealkalizers • Reactors • Deaerators • Pressure Filters • Continuous Blowoff Systems
Condensate Return Systems • Steam Specialties

Circle 106 on Reader Service card for more data

Don't keep it to yourself

The editors of Power Industry are always interested in reader's views . . . no matter what they are. Only by keeping in close touch with readers can we determine what they want to read about, in what phases of their field they are most interested. What are your views on the subjects we cover? We will publish as many letters each month as is possible. Certainly, your letters won't be ignored. Write that letter now, while you are still thinking about it. We shall appreciate your effort.

CONSTRUCTION FEATURES *PLUS* CONTROLLED QUALITY

make Your Choice of the

L★A Deaerator

a Wise One indeed!

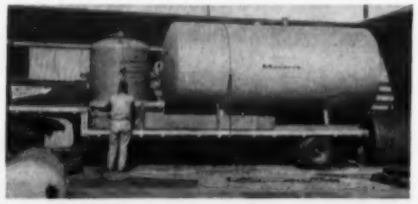
- Always completely assembled in our own API-ASME approved shop
- Always fabricated by our own skilled employees
- Constantly supervised by our own engineers
- Fabricated of highest quality materials
- Always a final check-out of the assembled unit
- One complete bulk shipment
- Jet atomizing, tray and combinations available
- All stainless steel internals
- Self-adjusting to all loads
- 10,000 to 2,000,000 lbs. per hr. capacities

Automatic welding machine in L*A shop

From your initial inquiry through the shipment of the completed deaerator, L★A Water Softener Co. takes complete responsibility. You are assured of the finest workmanship and control with constant inspection and supervision by our qualified engineers as fabrication and assembly proceed. Consistant top quality equipment is the result.

You KNOW where your L★A Deaerator is made! And this complete control from one source enables L★A to deliver **on schedule** and ready for quick installation.

100,000 lbs. per hr., 10 min. storage unit being loaded for delivery to eastern chemical manufacturer



May we send you a copy of our new Deaerator booklet? Ask for Bulletin 102-A

L★A WATER SOFTENER COMPANY

1007 Air Way, Glendale 1, California

REPRESENTATIVES IN PRINCIPAL CITIES

Demineralizers • Hot Process Softeners • Floc Treators • Deaerators • Zeolite Softeners • Dealkalizers

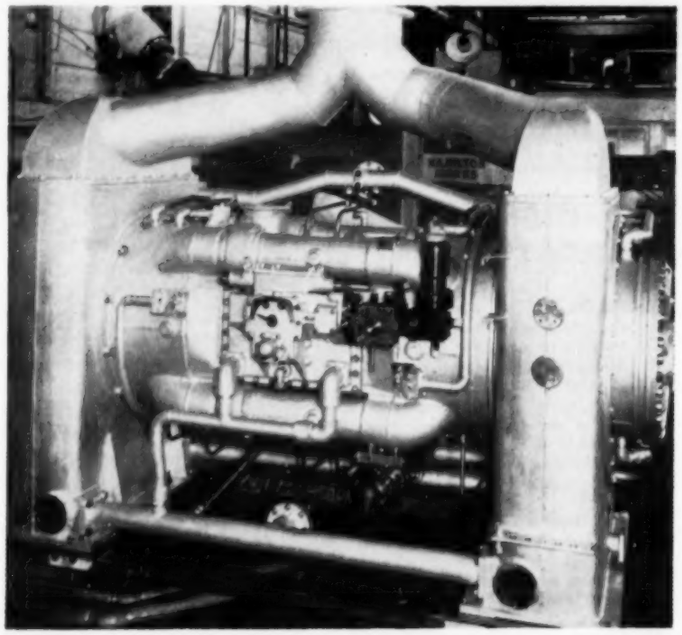
Circle 153 on Reader Service card for more data

710-Turbocharged free-piston engine produces low-cost pneumatic power

Radically new design of free-piston engine gives greater power-to-weight ratio, permits using variety of fuels. Also provides high starting torque and controlled variable speed without expensive transmissions and torque converters. Pistons are free to bounce in their cylinders — they are restricted by the cylinders, but not by the linkage through connecting rods for a crankshaft (as in a crankshaft engine).

Power output ranges from 125 shaft hp — available from a single gasifier — to 1000 shaft hp when gasifiers are used in multiples. DL Series uses single stage compression and a patented movable compressor to produce output of 500 shaft hp. FP-165 series has two-stage compression unit producing 250 shaft hp with turbocharging. The second stage, by using the energy from the outward piston stroke, affords balance energy and permits rise in output power without excessive stress and heat on compressor discharge valves.

Free-piston gas turbine plant can be made directly reversible and will provide reverse power to 65% of its forward rating. Can be combined so that multiple gasifiers supply one turbine to provide a wide range of power outputs. Units are virtually vibrationless, requiring only a minimum foundation structure. Units operate at about 1000 F, permitting use of ordinary steels. Lightweight, small size units can be handled without cranes. BALDWIN-LIMA-HAMILTON CORP.



711-Integrated system for light, acoustics

Integrated lighting system incorporates facilities for lighting, noise control, and structural header sections for movable partitions. System uses large gridwork positioned below all structural members of the building. Space above gridwork can be used for ducts, feeds, pipes, sprinklers, other services. Lamps operate on 120 ma and are shielded by transverse members of the grid system for low brightness. Transverse members of the grid system are perforated metal shells containing fiberglass filling for sound absorption. Longitudinal grid members contain wiring and circuiting. SMITHCRAFT LIGHTING.

(continues on page 38)

P/I handy guide to engineering literature

AIR CLEANING EQUIPMENT

120-Which is the best dust collection system?

Let Buell specify a system to meet your exact dust collection needs. Read page 30 — Buell Engineering Co., Inc.

400-Manual of dust collection

"The Collection and Recovery of Industrial Dusts," Manual 101, discusses types of dust and techniques used in analysis. 32 pages. Buell Engineering Co., Inc.

AIR CONDITIONING, HEATING, VENTILATING

101-Gas unit heaters solve space heating problems

Fan or blower heaters in 10 sizes from 25,000 to 300,000 Btu have many special features. Read page 46 — Reznor Manufacturing Co.

402-How to estimate your air handling needs

Bulletin E-57 describes propeller fans and special related equipment. Tables help in estimating air-handling requirements. 24 pages. Aerovent Fan Co., Inc.

104-Try plastic blades for your cooling tower fans

Plastic fan blades resist vibration, corrosion, abrasion, mechanical damage. Read page 43— Hartzell Propeller Fan Co.

131-Pneumatic control system aids plant efficiency

Case history of how temperature and humidity control is maintained at A. B. Dick Co. plant. Read pages 6, 7 — Johnson Service Co.

113-To drive out foul air

Drive out fumes, gases, stagnant air from boilers, other confined places. Read page 42 — Coppus Engineering Corp.

403-Unit heaters provide 15,000 to 684,000 Btu

Engineering data on horizontal, downblast, and combination unit heaters using steam or hot water is given in Bulletin 1523. 28 pages. Sturtevant Div., Westinghouse Electric Corp.

BOILERS AND ACCESSORIES

144-Is space a factor in your boiler needs?

Free 1/4-inch scale template of complete modulatic water-tube boiler line makes planning easy. Read page 17 — Vapor Heating Corp.

125-Gives hot water fast, economically

Pick heaters supply hot water in desired quantity and at desired temperature. Read page 44 — Pick Manufacturing Co.

108-Keeping tabs on boilers made easy

Eye-Hye remote-reading gages give accurate boiler water level readings. Mount on wall or panel. Read page 40 — The Reliance Gauge Column Co.

122-Firebox converts for coal firing

Complete units for oil, gas, or oil-gas firing. Easily converted for coal firing. Read page 33 — The International Boiler Works Co.

106-Performance record speaks for itself

Case histories prove that C-B heat transfer systems aid the process industries. Read page 37 — Cochrane Corp.

132-Case history on integral-furnace boilers

Carling Brewing Co. depends on 2 B&W boilers to furnish steam for process and for plant heating. Read page 23 — Boiler Div., Babcock & Wilcox Co.

404-Package boiler capacity tables

Bulletin PSG-2 contains tables of capacities, dimensions, and weights of nine typical package boilers. Includes illustrations of firing and control equipment plus recommendations for field installation for three pressure classes. 10 pages. Henry Vogt Machine Co.

(continues on page 40)

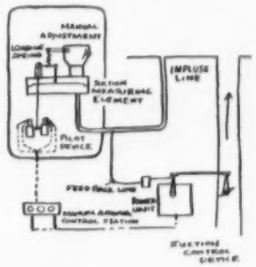
RAMBLINGS ON INSTRUMENTATION

The lowdown on boiler plant control systems—Chapter 4

Last month we talked about combustion control systems in general . . . now let's get ~~commercial~~ specific and talk the operating advantages of Hays Electric Combustion Control.

Among other things, a major point is the characteristics of electricity itself. When an impulse is given to a power unit, for instance, the signal travels at the speed of light. For those interested, this is 186,000 miles per second (on clear days).

As an example of how this electricity is used in a typical control problem, please direct your attention to this version of a furnace draft controller as rendered by our staff artist Picasso O'Toole:



Perceptive readers will note that the actual draft or negative pressure to be controlled acts upon a slack type diaphragm sensing element located within the controller. The impulse is carried to the controller from the point being measured by means of a ½" or so black iron pipe (available from Sears, Montgomery Ward or your nearest plumbing supplier). The action of the draft upon the diaphragm is opposed by the loading spring, an adjustable unit, simply set. Through direct linkage, one of two sealed magnetically operated mercury switches is closed, operating the electric power unit directly. The power unit moves until the draft again reaches the value for which the controller is set.

This Hays power unit, by the way, is quite a versatile pile of gears and castings. Electrically operated it has exceedingly high starting torque furnished by a fully enclosed capacitor type motor with no brushes, slip rings or commutators. Special insulation is used so that the power unit can be installed in a high ambient temperature. It can be stalled for several minutes without injury, and it's equipped with overload protection and adjustable limit switches. Finally it can be operated manually by simply flipping a switch at the manual—automatic control station located on the controller itself.

If you're the heckling type, and are still with us, you might be tempted to ask a couple of embarrassing questions. For example "Does Hays really know the technology of Combustion Control?", and "Where have Hays Control Systems operated and how well?"

Our learned engineering vice presidents have assembled a series of technical monographs to answer question number 1 above. If you want the real lowdown just ask us for any of these titles:

1. Steam pressure control. Pub. 965-105
2. Automatic combustion control for spreader stokers. 973-108
3. Automatic combustion control for oil burners. 971-111
4. Instrumentation and controls for small steam plants. 968-113
5. Automatic control applied to measuring and controlling air flow in boilers. 974-114
6. Combustion controls for multiple fuel firing. 1101-269
7. Combustion and combustion guides.

To prove the equipment works, we've gotten permission from some of our good customers to print up booklets describing the results obtained in their plants. These include:

1. Baldwin Locomotive Works—three 16,000 PPH boilers at 300 psi, pulverized coal firing
2. A. B. Dick Company—three 25,000 PPH boilers at 125 lbs., stoker gas fired
3. American Tobacco Company—three 25,000 PPH boilers at 90 psi, stoker
4. Sunshine Biscuit Company—one 30,000 PPH boiler at 1500 lbs. oil fired

So, if you want any further proof (or if you'd like to get mail) just drop us a line. Next month we'll go into the story on combustion guides.

Phil Sprague Jr.

President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

Circle 146 on Reader Service card for more data

EYE-HYE

gives quick, accurate boiler water level reading for each drum at new automotive plant

Close-up of one of three panels shown below, in power plant of Chrysler Stamping Plant, Twinsburg, Ohio.

Here, as in thousands of other plants, operators "keep tab" on boiler water levels easily, quickly — with EYE-HYE conveniently mounted on panel or wall where wanted.

EYE-HYE is simple, safe, sure — easy to read from its illuminated green indicating liquid. It is sensitive to slightest level changes. Has no mechanical parts — is completely hydrostatic. Set at factory for the boiler it's ordered for; no adjustments or tampering possible on location. EYE-HYEs are available for any boiler pressure.

As an extra precaution, if warning signals are wanted, EYE-HYE can be equipped to actuate auxiliary lights and/or horns in various parts of the plant.

There are many uses for EYE-HYE Remote Reading Gages. Besides the main boilers, it can do valuable service on feed water heaters, waste heat boilers, flash tanks, storage tanks, etc. When writing for information, mention your working steam pressure.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Circle 108 on Reader Service card fo more data

PI handy guide

. . . starts on page 39

Thermodynamics basics

Seven-part series on thermodynamics basics from concepts and definitions through heat balances. Text is amplified by charts and diagrams, sample problems. 50 pages. POWER INDUSTRY reprint. (50¢ per copy — send check or money order — quantity rates on request.)

BUILDING MATERIALS

126-Control enclosures made to your specifications

Instrument panels, control desks, housings, enclosures fabricated to your exact specifications. Read page 35 — THE KIRK & BLUM MFG. CO.

405-Descriptive data on steel building products

American building products line includes asphalt-impregnated Steelbestos roofing and siding, plant ventilators, insulated Pan-L-Walls, cellular steel electrical flooring, and steel decking. Bulletin reviews complete erection service. 8 pages. AMERICAN STEEL BAND CO.

ELECTRIC DISTRIBUTION

133-For dependable renewable fuses

Buy dependable renewable fuses from strategically located warehouses. Read page 46 — MONARCH ELECTRIC CORP.

138-Circuit breaker protects against fault currents

FB dc circuit breakers have fast current-limiting action against fault currents of 1000 to 150,000 amps. Read page 19 — SWITCHGEAR DIV., I-T-E CIRCUIT BREAKER CO.

118-Interchangeable trays support cable, wiring

Ladder and basket type cable trays are interchangeable for installation ease, flexibility. Steel or aluminum. Read page 27 — THE GLOBE CO.

127-Unit substations protect against short circuits

Unit substations with Cordon breakers limit damaging fault

Power Industry

a Putman-Style magazine

featuring all these unique elements:

- TERSE, VITAL EDITORIAL
- HAND-PICKED CIRCULATION
- 'EXECUTIVE' FORMAT
- QUALITY READERSHIP
- HIGH READER ACTION

Stops Leaks COLD!

No Heating of Work or Stick!

Instantly seals— While Water is Running!

- **Cracked soil pipes**
- **Radiator leaks**
- **Sandholes in castings**
- **Concrete wall seepage**

Here's a pipe mending cement that stops leaks as fast as you find them. Works on hot or cold surfaces . . . even steam lines. . . . Needs *no heating*. Use it on metal or plastic pipes, downspouts, laundry tubs, etc. — seals against water, steam, gas, acid, brine, etc. No waste . . . no delay *. . . no need to drain system or container.*

See your supplier . . . or write direct for sample.

LA-CO BRAND

LAKE CHEMICAL CO.

3090 W. Carroll Ave., Chicago 12, Ill.

Circle 154 on Reader Service card for more data

currents to protect equipment. Read page 4 — BULLDOG ELECTRIC PRODUCTS CO.

406-Transformers to 100 kva are self protecting

ACP transformers resist effects of lightning, overloads, short circuits. Bulletin 61B-7309C describes molded reinforced blocks with brace windings against short-circuit forces, internally mounted low-voltage breaker. 8 pages. ALLIS-CHALMERS MANUFACTURING CO.

Electrical basics

Six-part series reviews fundamental concepts of conductivity, resistance, magnetism, direct current and alternating current machinery, single-phase, polyphase alternating current circuits. Fifty-two pages. POWER INDUSTRY reprint. (50¢ per copy — send check or money order — quantity rates on request.)

ELECTRIC UTILIZATION

129-Cartridge heaters solve spot heating problems

Chromalox electric cartridge heaters solve flexing, moisture, abrasion problems. Read page 32 — EDWIN L. WIEGAND CO.

409-Mechanical specs on magnetic motor starters

Bulletin GEA-6611 describes magnetic motor starters in NEMA sizes 0 and 1 for machine tools, pumps, hoists, blowers, fans, compressors, motor control centers. Includes data on open and enclosed forms, nonreversing, and multispeed starter forms. 20 pages. GENERAL ELECTRIC CO.

FUELS AND FIRING EQUIPMENT

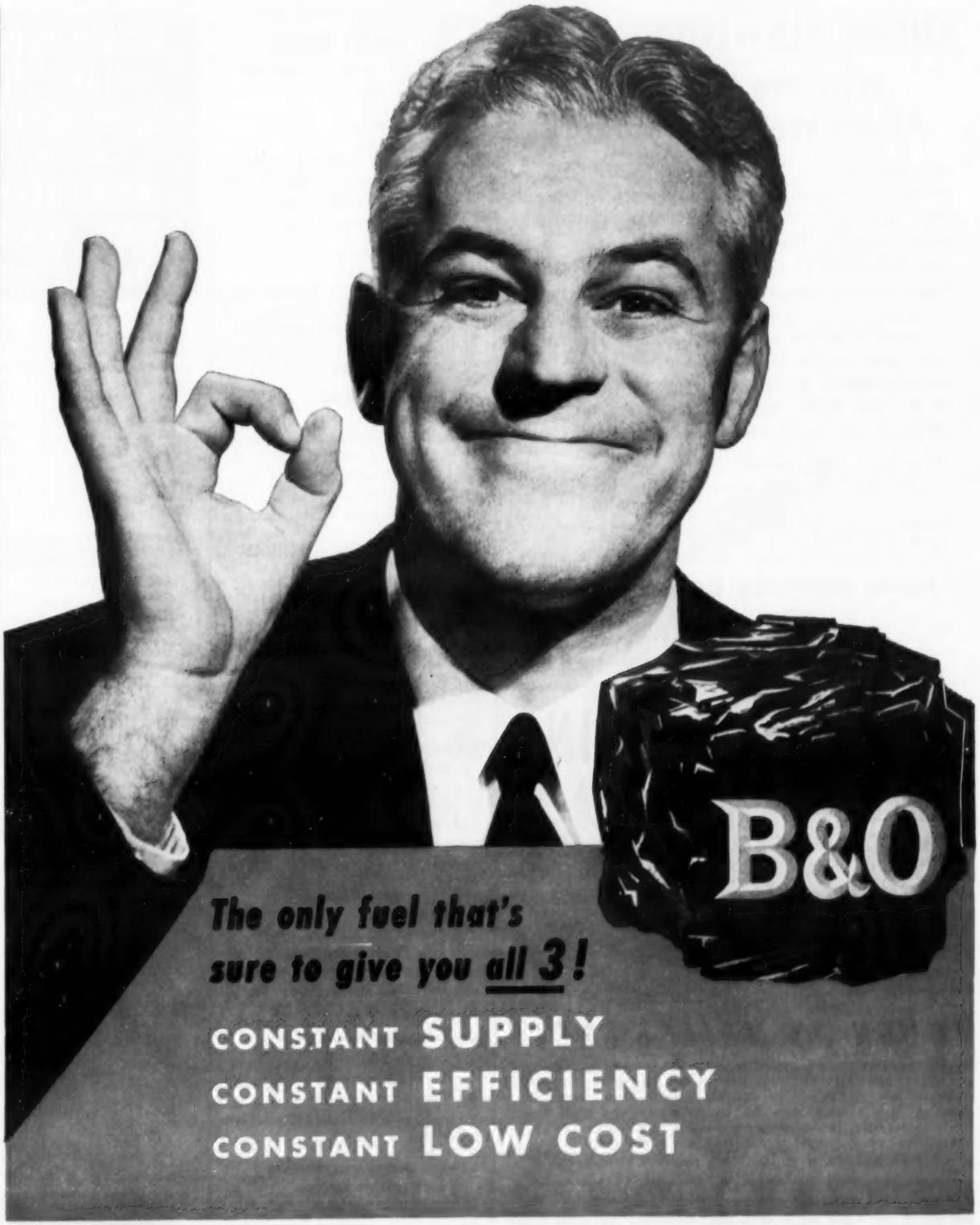
152-Full fuel capacity is always available

With these fuel oil pumping and heating systems for heavy bunker or light furnace oil, full capacity is always possible. Read page 47 — THE ENGINEER CO.

149-Fuel oil units save space

Compact, space-saving fuel oil pumping and heating units are available in both medium- and high-pressure types. Read page 37 — NATIONAL AIROIL BURNER CO., INC.

(continues on page 42)



B&O BITUMINOUS COALS FOR EVERY PURPOSE

Ask our Man! BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD. *Phone* LExington 9-0400

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CHEMICALS vs EQUIPMENT

Why the Wrangle About Water Treating?

Let's face the facts. In many cases, chemicals alone can do an excellent job of treating water. In other cases, equipment is justified by results and operating costs. And many times, a combination of equipment and chemicals is the answer.

Elgin is wholly unbiased because we supply all types of water treating chemicals and water conditioning equipment.* Backed by our half-century of experience, your nearest Elgin representative can make recommendations based squarely upon your specific needs. And Elgin's reputation for follow through service to users assures complete satisfaction.

For facts, write for bulletins . . . or, better still, let us put you in touch with our nearest representative.

*Manufacturers of Water Treatment, Feeders, Testing Equipment, Zeolite Water Softeners, Deionizers, Dealkalizers, Clarifiers, Aerators, Deaerating Heaters, Filters, and related products.

ELGIN SOFTENER CORPORATION

ESTABLISHED 1908

138 N. Grove Ave., Elgin, Illinois

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INSTANT SETTING

CONCRETE FLOOR PATCH

TEST IT ON TRIAL OFFER

TOUGH AS NAILS! FAST!

Repair broken factory floors without the usual traffic tie-up. Simply shovel INSTANT-USE into hole or rut—tamp smooth—truck over! No waiting! INSTANT-USE bonds tight to old concrete—right up to a feather edge. It's tough. Wears like iron. Won't crack or crumble. Install complete overlay where floors are badly chewed up. Used indoors or out. Immediate shipment.

MAIL COUPON for TRIAL OFFER and FREE BROCHURE

INSTANT-USE

FLEXROCK COMPANY (Offices in principal cities)
3605 Filbert St., Philadelphia 1, Pa.

Please send me complete INSTANT-USE information, details of TRIAL ORDER PLAN and Free INSTANT-USE BROCHURE—no obligation. (Clip and attach Coupon to Company letterhead.)

Name.....
Title.....
Company.....
Address.....

Circle 103 on Reader Service card for more data

P/I handy guide

. . . starts on page 39

150-How to choose the right coal

Depend on Pickands Mather to furnish the right coals for industrial use. Read page 45 — PICKANDS MATHER & CO.

140-Burn coal the modern way

With a Detroit Stoker, you can burn coal the efficient, dependable way — and save 10 to 40% over other fuels. Read page 51 — DETROIT STOKER CO.

143-Superior coal for difficult jobs

Skilled technicians at Guyan Eagle keep constant watch to insure rigid adherence to buyer's specifications. Read page 9 — GUYAN EAGLE COAL CO.

INSTRUMENTS AND CONTROLS

107-Gage your needs — pick your gage!

USG gages meet requirements in all price ranges for supergages, industrial gages, boiler gages, thermometers, recorders. Read page 44 — UNITED STATES GAUGE.

146-Lowdown on combustion controls

Chapt. 4—advantages of Hays Electric Combustion Controls. Also bibliography of other bulletins. Read page 39 — THE HAYS CORP.

148-Keep your finger on the pulse

Depend on Ellison gages to indicate draft conditions at all times — they are easier to read, dependable. Read page 42 — ELLISON DRAFT GAGE CO.

151-Temperature recorder uses no ink!

Model 200 uses no ink to make temperature recordings. Read page 36 — THE ELECTRIC AUTO-LITE CO.

128-Sequential annunciators spot trouble for you

Need automatic, fail-safe, low-cost monitoring? Investigate Scam sequential annunciator systems. Read page 36 — THE SCAM INSTRUMENT CORP.

135-Dual-purpose controls solve control problems

Single element independently controls temperature and pres-

YOUR FINGER IS ON THE PULSE OF YOUR BOILERS with *ELLISON* DRAFT GAGES ON THE JOB!

Proper combustion of fuels is dependent upon draft—Ellison Gages show you the draft condition at all times—they are easier to read, accurate, dependable.

Straight-line and Dial types—bell actuated and diafram actuated—built for durability and accuracy. Exclusive features such as transluscent glass scale, unitized mechanism that can be slipped out of case, practical illumination, nonfogging and dust sealed. A bank of Ellison Straight-Line Draft Gages at the South Shore Destructor Plant, Brooklyn, N.Y., is shown. Send for Bulletins 122 and 124.

ELLISON DRAFT GAGE CO., INC.

548 W. MONROE ST. Since 1896 CHICAGO 6, ILL.

The Ellison Line Also Includes:

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Vertical Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages—U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types—Pitot Tubes—U Path Steam Calorimeters—Portable Gas Analyzers-Orsat Type

Circle 148 on Reader Service Card for more data

Drive out

FOUL AIR

Blow in

FRESH AIR

with Coppus Type A Ventilator

Assure greater safety, comfort for workers . . . get greater efficiency.

Drive out dangerous fumes, gases, stagnant or hot air from boilers, cable manholes, tanks, vats and other confined places. *Supply fresh air continuously.*

Send now for further information. Coppus Engineering Corporation, 190 Park Avenue, Worcester 2, Mass.

MANHOLES made safe for workers' entrance within minutes.

BOILER AND TANK INTERIORS cooled by Coppus. Fresh air supplied continuously.

ANOTHER **COPPUS** "BLUE RIBBON" PRODUCT

Circle 113 on Reader Service card for more data

sure. Circuit arrangement can be adapted to your specific needs. Read page 38 — The Mercoid Corp.

110-Detect oxygen in feedwater

Spotting oxygen in feedwater shows where corrective steps are needed to prevent corrosion. Read page 31 — Cambridge Instrument Co., Inc.

421-How to measure, control fluids

Bulletin 54-766-38 describes Veriflow meter for measuring, indicating, and totalizing liquids and Veritrol that combines rate-of-flow control with indicating and totalizing. 8 pages. The Hays Corp.

LUBRICATION

112-Stop motor burnouts

Lubricate with Non-Fluid Oil for steady run with cool bearings and clean frames. Read page 47 — New York & New Jersey Lubricant Co.

MAINTENANCE ITEMS

100-Keep boilers on the line

Depend on Wilson tube cleaners and expanders for your boiler maintenance. Read page 29 — Thomas C. Wilson, Inc.

109-Better collars give better jobs

Solid steel collars stay put. Held on shaft by Unbrako set screws. Read page 46 — Hallowell Power Transmission Div., Standard Pressed Steel Co.

137-Tube fittings for fast, easy assembly

Parker tube fittings for instrumentation and processing are easy to use, safe, dependable. Read page 10 — The Parker Appliance Co.

119-Visual control system saves you money

Boardmaster Visual Control gives graphic picture of your operations. Saves time and money, prevents errors. Read page 48 — Graphic Systems.

124-High fuel costs can burn up your profits

Let Airetool's tube expansion and cleaning equipment prevent profit-robbing scale-clogged tubes. Read page 26—Airetool Manufacturing Co.

103-Quick patch for concrete floors

Instant-use bonds tight to old concrete. Won't crack or crumble. Read page 42 — Flexrock Co.

114-Replacement tubes for any boiler

BTA carries boiler tube sizes and gauges for any make of boiler for quick parts replacement. Read page 34 — Boiler Tube Co. of America.

154-5-Simplify your maintenance program

Investigate Lake Chemical products for safe, dependable, long-lasting repair jobs. Read pages 40, 44 — Lake Chemical Co.

422-Alloy, stainless steel cap and set screws

Catalog 877 covers standard socket screw products, pressure plugs, dowel pins. Includes data on diameters, threads, materials, uses. 32 pages. Standard Pressed Steel Co.

423-Welding rod comparison chart

Bulletin DH-1218-K includes handy chart showing typical uses of gas welding rods, bare electrodes, automatic welding wire, and metal spray wire. Includes physical properties as welded, tensile strength, elongation, average Rockwell hardness. 4 pages. American Chain & Cable Co., Inc.

MANAGEMENT

Engineering Economics Basics

Handy power basics reference on engineering economics gives samples of sound and faulty economic calculations. Reviews basic principles leading to wise management economic decisions. Advises on taxes, depreciation, amortization, etc. 30 pages. Power Industry reprint. (50¢ per copy — send check or money order — quantity rates on request.)

MATERIALS HANDLING (BULK)

102-Store flowable bulk materials

Unique super-concrete stave storage bins solve many storage problems. Read page 34 — The Neff & Fry Co.

425-How to store bulk materials

Storage bins for bulk materials such as ashes, coal, coke, sand, and lime are described. Includes tables of densities of flowable materials, capacities, description of wall construction, test data, other relevant engineering data. 30 pages. The Neff & Fry Co.

MECHANICAL POWER TRANSMISSION

427-Engineering manual on V-belt drives, sheaves

Handy tables in Data Book 10 make possible, without calculation, quick selection of Poly-V belts and sheaves for drives of any speed or horsepower rating. Covers theory and application, installation, troubleshooting. 112 pages. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

(continues on page 44)

Here's Real Proof of the Superiority of Hartzite Plastic Cooling Tower Fans

Since Hartzite plastic was introduced in 1941, one leading producer of petroleum products* has purchased 411 Hartzell cooling tower fans with Hartzite plastic blades. This figure does not include the additional units supplied to this customer by the cooling tower manufacturers who use Hartzell fans on their towers.

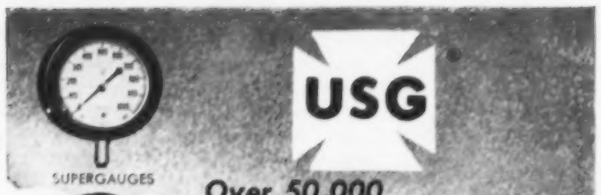
What better proof could you ask of the superiority of Hartzite plastic fans than this complete acceptance by one of the largest users of such equipment. Beyond all doubt, Hartzite has proved itself to this customer and to thousands of other cooling tower operators as the fan blade material most resistant to vibration, corrosion, abrasion and mechanical damage.

For complete details on Hartzell fans, and how they can help you cut cooling tower maintenance costs, write today for free Bulletin A-111 or call your nearby Hartzell field engineer.

*Name on request.

HARTZELL Propeller Fan Co.
Division of Castle Hills Corp.
910 Thomas Blvd. Piqua, Ohio

Circle 104 on Reader Service card for more data



Over 50,000 different gauges to meet every requirement

INDUSTRIAL GAUGES

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RECORDERS

Gauge for gauge—in every application classification—in every price range—you can't beat USG for value. USG has a line to meet every price and performance requirement.

USG gauges are installed on 6 out of 10 original pieces of equipment . . . the selection by so many buyers who demand both quality and economy being proof of USG values.

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USG UNITED STATES GAUGE
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Home of the **SUPERGAUGE**

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NO LEAK
Seal for:
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WATER
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PROPANE
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GASOLINE
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...with PIPETITE-*Stik* Pipe Joint Compound

You get a perfect joint every time with PIPETITE . . . as easy as 1-2-3 strokes across the pipe threads. Approved by industrial laboratories and government agencies. For all metal and plastic threads. Non-toxic . . . non-corrosive . . . contains no lead. Withstands pressures to 5000 p.s.i., temperatures to 750° F.

Get it in the convenient, economical 12-stick package. Your supplier has PIPETITE Stik . . . or write us for a sample.

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LAKE CHEMICAL CO.
3090 W. Carroll Ave., Chicago 12, Ill.

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Eliminate "P I" time with a* **PICK**

Pick STEAM INJECTION WATER HEATERS

INSTANTANEOUS WATER HEATER

With the Pick Instantaneous Water Heater, processes are speeded up and made easier. Designed for high pressure steam (40#-125# psi), the Pick Heaters supply hot water in desired quantity and with accurate temperature control. Either intermittent or sustained operation, the Pick Instantaneous Water Heater is your most dependable source for hot water. Check these other cost saving features of the Pick Heaters.

- **No Storage Space** — compact design permits out-of-the-way installations in corners, on walls, overhead, etc.
- **Maintenance Cost Is Low** — can be cleaned in minutes, worn parts easily replaced.
- **Fuel Savings Substantial** — steam injection is the most efficient method known for heating water. No heat loss as water is heated only as used, no storage tanks for water to stand and cool off.

* Process Idle Time — the time your employees waste waiting for hot water.

Exact temperature control

FOR ALL INDUSTRIAL APPLICATIONS

Primary Heater
Capable of supplying any specified volume of hot water up to 300 gallons per minute at 140° F. rise. These heaters are practical as a primary source of hot water for countless industrial needs.

Supplementary Heater
Easy installation and accurate control at any temperature makes these heaters useful for specialized "spot" application near the point of use.

"Booster" Heater
To augment overloaded or currently inadequate facilities, these heaters can be installed to automatically "boost" and correct temperature deficiencies.

Mail this coupon today for further information on Pick Instantaneous Water Heaters, to:

PICK MFG. CO. Dept. IP-57
West Bend, Wis.

Name.....
Company..... Title.....
Address..... City..... State.....
Please check below reason for request:
☐ Application ☐ File ☐ Other.....

PICK MANUFACTURING CO. West Bend, Wis.

Circle 125 on Reader Service card for more data

P I handy guide

. . . starts on page 39

428-Shaft-mounted drives give ratios to 24:1

Tables in Bulletin 57045 aid in selecting Falk drives for electric motors. New drives give higher ratios without altering outside dimensions or torque ratings. For horizontal or vertical application in ½ to 30 hp. 4 pages. THE FALK CORP.

429-Variable-speed drive for speeds from top to zero

Bulletin 522 gives mechanical specifications on variable-speed transmissions. Drive controls speed from top to zero plus reverse without stopping motor. 8 pages. GRAHAM TRANSMISSIONS INC.

430-Dry fluid drives get higher ratings

Larger Flexidyne dry fluid drives and couplings now have horsepower ratings 50% over former maximum. Tables in Bulletin A654 show exact motor sizes in range to 75 hp at 1750 rpm for larger Flexidyne sizes. 4 pages. DODGE MANUFACTURING CORP.

NUCLEAR

How to plan your nuclear power plant

"Nuclear Power Engineering," by Henry G. Schwenk and Robert H. Shannon, covers design, construction, and operation of nuclear power plants. Includes essential physics fundamentals plus detailed design features of specific power reactors. Other related subjects include system components, radiation and its effect on equipment and health, plant sites, economics. 344 pages. $6.50. MCGRAW-HILL BOOK CO., 327 West 41st St., New York 36, N. Y.

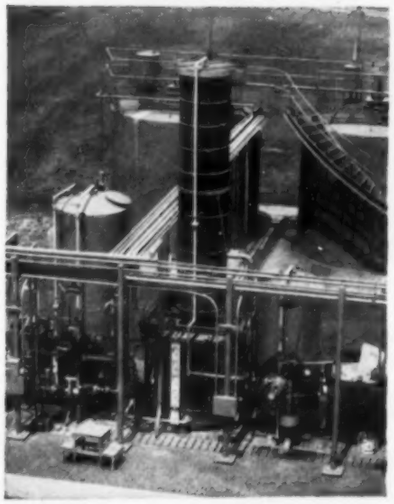
PIPING, TUBING, AND HOSE

123-Seamless metal hose assemblies

Use custom-constructed hose assemblies for your power system. All sizes available for any application. Read page 36 — COBRA METAL HOSE.

ILLCO-WAY

ionXchange



"SILICA: 0.003 PPM, OTHER SOLIDS UNMEASURABLE..."

With some doubt as to the outcome, the de-ionization units pictured above were installed outdoors at a Texas power and light company, to replace evaporation equipment as a means of purifying feed water for a high-pressure boiler. After three years, results far exceeded guarantee and expectations. From raw water containing 27 ppm of silica and dissolved solids totaling 365 ppm, the quality of the effluent is reported as: "Silica, zero to 0.005 ppm, average 0.003 ppm. Other solids are unmeasurable."—This is a good example of what modern ILLCO-WAY ionXchange can accomplish.

BOILER FEED WATER FOR POWER PLANT

The particular plant shown above consists of a cation exchanger, an aerator, and a mixed-bed deionizer. The large tanks in the background hold a supply of regenerants. Operation is manual throughout, a preference of the purchaser. *Results have proved even more economical than expected.*

ionXchange

ILLINOIS WATER TREATMENT CO.

ILLCO-WAY

840 CEDAR ST.
ROCKFORD,
ILLINOIS

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

Circle 142 on Reader Service card

PUMPING EQUIPMENT

116-Do you handle heavy fuel oil?

SU pump unit handles heavy fuel oils. Large choice of pumps and motors. Read page 29 – TUTHILL PUMP CO.

105-Add liquid ends as needed

Compound any simplex or duplex pump as needed. Pumps cover range of 30 cc/hr to 1648 gph. Read page 8 – PHILADELPHIA PUMP DIV.

103-Save Btu's cut kw costs!

Mechanical seals for boiler feed pump service can save you dollars. Read page 52 – BYRON JACKSON PUMPS INC.

431-Data sheet covers controlled-volume pumps

Data Sheet D-57-1 describes methods of combating corrosion and delignification in cooling towers. Controlled-volume pumps meter precise quantities of chemicals to cooling water. 4 pages. MILTON ROY CO.

432-How to calculate net inlet head

Bulletin 122 describes Type BFI boiler feed pumps for high-pressure service. Pump is horizontal, multistage, diffuser type with single inlet impellers arranged in series. Capacities to 4000 gpm, discharge pressures to 3500 psig. Bulletin includes density and vapor pressure conversion chart and formulas for calculating net inlet head. 12 pages. PACIFIC PUMPS INC.

REFRACTORIES AND INSULATION

433-Pipe insulation for temperatures to 1200 F

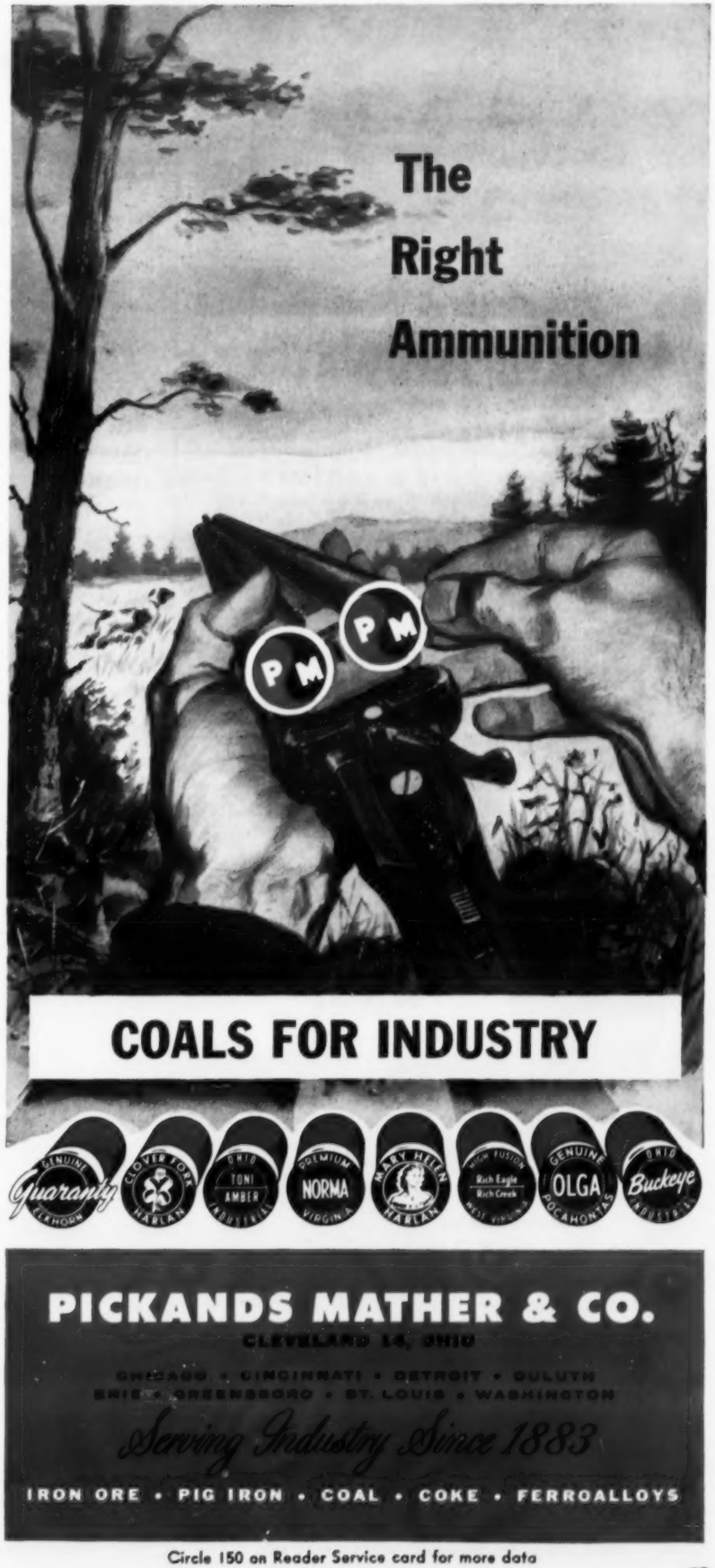
Bulletin A-407 describes Tab-Lok pipe insulation for steam piping and hot lines to 1200 F. Tab-Lok is water repellent, has high refractory value, removes easily for line inspection. Bulletin gives complete physical data, standard sizes available. 4 pages. THE EAGLE-PICHER CO.

REFRIGERATION

136-Air-cooled condenser gives higher vacuum

Aero vapor condenser produces higher vacuum than other types with more economy of power and steam. Read page 28 – NIAGARA BLOWER CO.

(continues on page 46)



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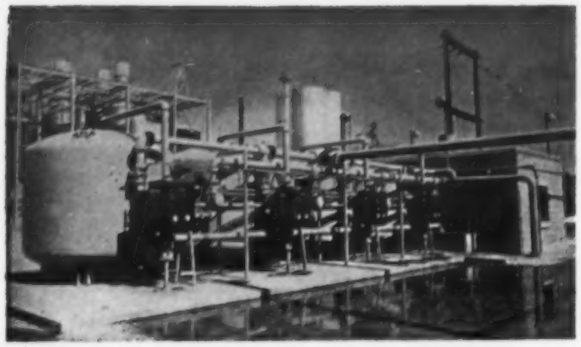

BOILER FEEDWATER TREATMENT

(for over half a century)

Complete plants for water softening, demineralization, silica removal, de-oiling of condensate, clarification, de-alkalizing and all other requirements.

Send for Bulletin BFT-11 or Nearest Field Representative.

H&T SERVICE

HUNGERFORD & TERRY, INC.

CLAYTON 1, NEW JERSEY

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HALLOWELL

SOLID STEEL COLLARS

Size-marked for quick identification in 43 stock sizes

And these precision-machined solid steel collars stay put because they are held in place on the shaft by the famous UNBRAKO Self-Locking Socket Set Screw. Authorized industrial distributors carry complete stocks in sizes from 1/8" to 3" inclusive. Write for Bulletin 868. STANDARD PRESSED STEEL CO., Jenkintown 39, Pa.

STANDARD PRESSED STEEL CO.

HALLOWELL POWER TRANSMISSION DIVISION — SPS — JENKINTOWN PENNSYLVANIA

Circle 109 on Reader Service card for more data

handy guide

. . . starts on page 39

Air conditioning and refrigeration basics

Five-part series that covers air refrigerators and heat pumps, mixtures of gases, gases and vapors, air conditioning processes, properties of refrigerants. Provides a thorough reference on air conditioning and refrigeration processes. 48 pages. POWER INDUSTRY reprint. (50¢ per copy — send check or money order — quantity rates on request.)

TRAPS, STRAINERS, SEPARATORS

111-Cut filter, strainer downtime

Headers, filters, and valves are quick coupling, non-short-circuiting. Read page 48 — RONNINGEN-PETTER CO.

121-Maintenance savings pay for ball float air relief traps

Ball Float air relief traps are ideal wherever air collects. Expert design and manufacture mean years of troublefree service. Read page 31 — ARMSTRONG MACHINE WORKS.

434-Liquid strainers clean themselves

Banks strainer strains fluids without downtime for screen cleaning. Tapered scraper constantly cleans screen. Keeping screen always clean permits using smaller perforations (0.023 in. dia) to remove minute particles. Bulletin W-6Sc gives complete data. 4 pages. GOLDEN-ANDERSON VALVE SPECIALTY CO.

435-Filters and strainers for oils, chemicals, liquids

Series 200 Multiplex fluid filters and strainers are described in Bulletin 45778. Available in bronze, stainless steel, aluminum, iron, and steel for hot or cold water, oils, chemicals, and other liquids. Capacities to 3300 gpm. 4 pages. RONNINGEN-PETTER CO.

VALVES AND REGULATORS

437-Data on valves for plumbing, heating

Air and vacuum radiator venting valves for steam and hot water systems, water mixers, relief valves, flow control valves, solenoid valves are described in Bulletin AIA 30-C-24. 16 pages. THE DOLE VALVE CO.

One dependable quality

Monarch

renewable fuses

From raw material to final inspection every part is MADE and ASSEMBLED under our own quality control.

STRATEGICALLY LOCATED WAREHOUSE STOCKS

Monarch ELECTRIC CORPORATION

Jamestown, New York

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THE *NEW* **REZNOR**

is the only GAS UNIT HEATER with ALL these advantages

- Clean, modern design, back as well as front . . . all controls and connections inside the cabinet.
- FlexiTemp control system with automatic two-speed fan control to provide nearly continuous air circulation and minimize temperature fluctuation (optional).
- No costly frills and gadgets . . . features which are needed only to meet special situations always separately listed and priced.
- Winter/summer switch with convenient pull cord for operation of fan alone during hot weather.
- Fan or blower models in ten sizes from 25 to 300 thousand BTU.

Write today for free catalog GN-57.

REZNOR

WORLD'S LARGEST-SELLING DIRECT-FIRED **UNIT HEATERS**

Reznor Manufacturing Company, 70 Union Street, Mercer Pennsylvania

Circle 101 on Reader Service card for more data

DO YOU HAVE A TWO-STAGE PRESSURE OR TEMPERATURE CONTROL PROBLEM

MERCOID® HAS THE SOLUTION

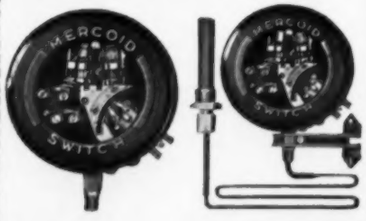
Mercoid DA-400 Series Controls are dual purpose controls (available for pressure or temperature) incorporating a single element operating two separate independently adjustable Mercoid magnetic mercury switches. Circuit arrangements can be supplied for various operations, a few examples are:

1. Close one alarm circuit at high setting and a separate circuit at low setting. Both circuits remain open between the high and low operating points of the two switches.

2. As an electrical interlock to open one circuit on a rise above, and the second circuit on a drop below the set operating point.

3. To provide two-stage control by opening one circuit on a rise and a second circuit on a further rise.

Pressure types available in 17 different operating ranges from 0-30" vac. to 300-2500 psi. *Temperature types* available in 11 operating ranges from -30-60°F. to 370-530°F.



All types are equipped with external adjustments and visible calibrated dial.

Our engineers are at your service—send in your control problem or
WRITE FOR BULLETIN CA-PT

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

Circle 135 on Reader Service card

439-How to choose a pressure regulator

Bulletin AD-2268 describes No. 960 bronze pressure regulators for pressure control of air or steam to 250 psi at 450 F. 6 pages. CRANE CO.

WATER SUPPLY AND TREATMENT

139-"Know-how" can solve your water problems

You can profit by expert help from specialists in water problems. Read page 31 — RANNEY METHOD WATER SUPPLIES, INC.

134-As up-to-date as Univac!

Remington Rand depends on Mogul water treatment program to protect multi-million dollar Univac plant. Read page 5 — THE NORTH AMERICAN MOGUL PRODUCTS CO.

117-Water treating plants to meet your needs

Whatever your boiler feedwater problem, let the experts solve it for you. Read page 2 — INFILCO INC.

142-Boiler feedwater for power plants

Case history shows astonishing success of Illco-Way IonXchange deionization units. Read page 45 — ILLINOIS WATER TREATMENT CO.

130-Complete boiler feedwater treatment

Complete plants for all feedwater requirements. Over 50 years' experience. Read page 47 — HUNGERFORD & TERRY, INC.

115-Chemicals versus equipment

Let Elgin specify water treating chemicals or conditioning equipment. Read page 42—ELGIN SOFTENER CORP.

153-Deaerators to 2 million lb/hr

Construction features plus controlled quality make L•A deaerators a wise choice. Read page 38 — L•A WATER SOFTENER CO.

440-Solids-contact reactor handbook

Bulletin 5001 discusses theory and problems of cold water clarification. Includes photographs and drawings of solids-contact reactors. 24 pages COCHRANE CORP. ♦♦

NON-FLUID OIL
TRADE MARK REGISTERED

IDEAL FOR PRESSURE SYSTEMS

Pressure lubrication calls for NON-FLUID OIL — The Modern Lubricant that can't dry out like ordinary greases and will not separate under pressure. It lubricates all the way until entirely consumed.

NON-FLUID OIL is long-lasting, strictly neutral and contains nothing of a residual nature that can clog fittings, causing bearings to run dry. Why choke your pressure system? Switch to NON-FLUID OIL and see for yourself why it is perfect for pressure systems.

Made in grades suited to every need. Write now for useful Bulletin No. 522 and free sample for on-the-job testing.

NEW YORK & NEW JERSEY LUBRICANT COMPANY
292 MADISON AVE., NEW YORK 17, N. Y.
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Atlanta, Ga. Greenville, S. C. Detroit, Mich.
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1896 61 1957 YEARS OF LUBRICATION SERVICE NON-FLUID OIL TO INDUSTRY

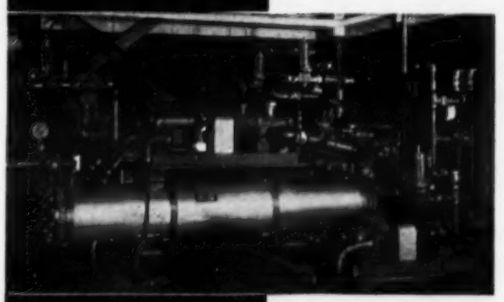
NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

Circle 112 on Reader Service card for more data

ENCO
Fuel Oil Pumping and Heating Systems

For heavy bunker oil or light furnace oil . . . 100 to 10,000 gallons per hour

Enco systems employ one, two or more pumps and heaters, interconnected so that full capacity is possible with any combination of pumps and heaters. Flexibility of design permits the use of any combination of rotary pumps, with motor or turbine drive; or piston type steam pumps. Any part may be cut out of operation for inspection or cleaning, without shutting down, where two or more pumps and heaters are included in the unit system.



Heaters are insulated and jacketed with removable heads at both ends for cleaning without breaking any piping connections or removing any tube bundles.

Full automatic oil pressure and temperature control, with relief valves for each pump and heater. Permits delivery of oil with safety, and at proper temperature and pressure for efficient burning.

Each unit is built to order and delivered ready to place on foundation and for connection to the station piping.

Write for Bulletin OB-53 describing Enco Gas and Oil Burners; and Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 WEST STREET
NEW YORK 6, N. Y.

EC 506

Circle 152 on Reader Service card for more data

Automatic filter

. . . starts on page 22

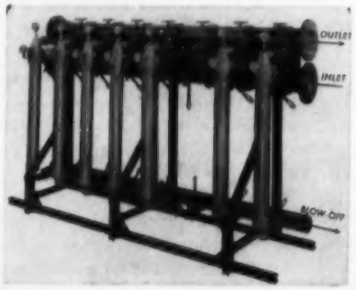
on the carriage above the sand. A suction pump takes dirty water to the washwater launder channel. Suction pressure in hood is slightly greater than pressure of backwash pump and this pressure differential prevents dirty backwash water from getting into main filter bed. Hood fits close to top of sand compartment.

By this method, only one filter compartment is out of operation at a time during backwash operation.

Results: Operating cost for solids removal is a minimum. No flocculating or other treatment chemicals are used. System works around the clock without maintenance — as filtration load rises, water level in tank rises and carriage starts its cleaning job. When bed is clean, carriage rests. When comparatively clean water is being received, unit remains idle, doesn't waste power washing itself needlessly.

Except for ordinary pump and mechanical maintenance, unit has been trouble-free since it first started operating in 1952. ♦ ♦

ELIMINATE DOWN-TIME
on your Filters and Strainers



Ronningen Model 208 Multiplex Filter with 1 unit removed from line for service—and all the others can continue to operate.

Bronze and copper construction; also all 316 stainless steel; also all steel.

All are Quick Coupling — Non Short-Circuiting. Sealed both ends. Each unit can be back washed and blown down in 5 seconds.

Heavy reinforced inner assures 150 PSI "dead short" without collapse.

Write for Bulletin 954P

STRAIN AGAIN WITH RONNINGEN
"Particles large or small, we filter them all"

RONNINGEN-PETTER CO.

Vicksburg, Michigan Phone Midway 8-5161

Representatives throughout U.S. and Canada

Circle 111 on Reader Service card

coming events

Oct. 7-9:
ASLE-ASME Lubrication Conference; Royal-York Hotel, Toronto.

Oct. 7-9:
National Electronics Conference; Hotel Sherman, Chicago.

Oct. 7-10:
Federation of Sewage & Industrial Wastes Association Annual Meeting; Statler Hotel, Boston.

Oct. 7-11:
AIEE Fall General Meeting; Hotel Morrison, Chicago.

Oct. 8-9:
Industrial Coal Conference; Purdue University, West Lafayette, Ind.

Oct. 10-11:
ASME-AIME Joint Conference on Solid Fuels; Chateau Frontenac, Quebec.

Oct. 10-11:
National Noise Abatement Symposium; Hotel Sherman, Chicago.

Oct. 21:
Air Pollution Symposium; The Franklin Institute, Philadelphia.

Oct. 21-23:
Engineers' Society of Western Pennsylvania Annual Water Conference; Penn Sheraton, Pittsburgh.

Oct. 21-25:
National Safety Congress and Exposition; Conrad Hilton, Congress, Morrison, and La Salle Hotels, Chicago.

Oct. 28-30:
American Nuclear Society Winter Meeting; Henry Hudson Hotel and Coliseum, New York City.

Oct. 28-31:
Trade Fair of the Atomic Industry; Coliseum, New York City.

Oct. 30-31:
Industrial Hygiene Foundation Annual Meeting; Mellon Institute, Pittsburgh, Pa.

Nov. 13-14:
Joint Armour Research Foundation—Midwestern Air Pollution Prevention Association Conference; Chicago.

Nov. 13-15:
ASA Conference on Standards; St. Francis Hotel, San Francisco.

Nov. 14-15:
AIEE Textile Conference; State College, Raleigh, N. C.

Nov. 14-16:
American Association of Refrigeration Engineers Semi-annual Meeting; Shoreland Hotel, Chicago.

Dec. 1-6:
ASME Annual Meeting; Statler Hotel, New York City.

Classified Advertising

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H. Emerson Thomas & Associates, Inc.
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and
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FOSTER QUALITY FULLY GUARANTEED
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Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.
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HERE'S A QUICK SOLUTION . . .
when you need low cost Electrical Power Equipment—

CHICAGO-ELECTRIC **"REBUILTS"**
Immediate Delivery!
Fully Guaranteed!

Check this partial listing . . .

MOTORS
SLIP RING
3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

HP	MAKE	TYPE	RPM
1200	*Al-Ch.	ANY	1800
600	*G.E.	M-63456	1800
300	G.E.	M-6345Z	1200
250	Al-Ch.	ARY-626J	1800
250	*G.E.	I-M-17A-10	720
200	G.E.	I-M-16	600
200	*West.	CW-950A	514
150	Cr-Wh.	50R	1800
150	West.	CW-874C	720
150	Al-Ch.	ANY	600
125	G.E.	I-M-15A	600
125	*G.E.	I-M-15A	600
100	G.E.	I-M-E13A-4	1800
100	G.E.	I-M-14	900
100	*G.E.	I-M	720
100	G.E.	I-M-15A	450
75	North-W	EW-50	1800
75	G.E.	MT-347-6	1200
75	G.E.	I-M-13	1200
75	G.E.	MT-356-8-75	900
75	Al-Ch.	ANY-33C	720

SYNCHRONOUS MOTORS
3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

HP	MAKE	TYPE	PF	RPM
1420	West.	HG	0.7	900
300	G.E.	ATI-6-285M	0.8	1200
300	*Ideal	SMM	0.8	257
275	*G.E.	ATI	1.0	450
250	Al-Ch.		1.0	1200
225	Elec. Machy		1.0	360
225	G.E.	TS-6244	1.0	300
200	G.E.	TS-7559	1.0	1800
190	Elec. Machy		1.0	720
150	Al-Ch.	SYN	0.8	1200
150	*Elec. Machy		0.8	1200
150	*West	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6214	1.0	277

MOTORS
SLIP RING — Crane and hoist
3 phase, 60 cycle, 220 or 440 volts (* 2200 volts or higher)

HP	MAKE	TYPE	RPM
100	G.E.	MTC-5546-8	900
80	G.E.	MTC-5552	600
50	G.E.	HIC	600
35	G.E.	MTC-5536	600
25	West.	CI-636-A	720
15	G.E.	ITC-5C09	900
11	West.	CI-E464-A	900
10	P & H	BW-6	1800
5	North-W	WRC	1200

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7500/3750	Chandy.	12/24—220/440
6000/3000	Chandy.	12/24—220/440
6000/3000	Chandy.	8/16—220/440
5000/2500	Optimus	6/12—220/440
5000/2500	Chandy.	8/16—220/440
1500/750	Chandy.	12/24—220/440
1000/500	Chandy.	12/24—220/440

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AIRETOOL MFG. CO. . . . . .Page 26
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ARMSTRONG MACHINE WORKS . . . . . .Page 31
ARLINGTON 74, MASS., Power Specialties Co., Inc., 171 Broadway, Mission 8-4030.
BALTIMORE 11, MD.: Wm. A. Milby Co., 27th St. and Remington Ave., HOpkins 7774.
BUFFALO 13, N. Y.: Award Engineering Co., 906 Niagara, GArfield 7497.
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BABCOCK & WILCOX CO., BOILER DIV. . . . . .Page 23
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BALTIMORE 1, MD.: (Home Office) J. K. Thorney, Baltimore & Charles Sts.
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CAMBRIDGE INSTRUMENT CO., INC. . . . . .Page 31
NEW YORK 17, N. Y.: (Home Office) 3778 Grand Central Terminal Bldg.

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COCHRANE CORPORATION .Page 37
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BOSTON 10, MASS.: Cochrane Steam Specialty Co., 55 Batterymarch St.
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HARRISBURG, PA.: Irvin H. Geiger, 216 Locust Street.
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RICHMOND 6, VA.: The Hawkins-Hamilton Co., 401-04 American Bldg.
ROCHESTER 18, N. Y.: David R. Mixsell Co., 1470 Monroe Ave.
WASHINGTON 6, D. C.: Robert M. Austin, Barr Bldg.
WASHINGTON 6, D. C.: Meleney Engineering Co., 720 Mills Bldg.

COPPUS ENGINEERING CORP. . . . . .Page 42
WORCESTER, MASS.: (Home Office) 262 Park Ave.

DETROIT STOKER CO. . . . . .Page 51
BUFFALO, N. Y.: Detroit Stoker Co., Ellicott Square Bldg.
GREENSBORO, N. C.: P. O. Stribling, Jr., 216 W. Market St.
NEW YORK, N. Y.: Detroit Stoker Co., 101 Park Ave.
PHILADELPHIA, PA.: Detroit Stoker Co., 1421 Chestnut St.
PITTSBURGH, PA.: Craig Equipment Co., Farmers Bank Bldg.
RICHMOND, VA.: The Hawkins-Hamilton Co., 1001 E. Main St.

ELECTRIC AUTO-LITE CO. . .Page 36
NEW YORK, N. Y.: Thomas Murchie, 49th Floor, Chrysler Bldg. MUrray Hill 9-1842.

ELGIN SOFTENER CORP. . . .Page 42
BALTIMORE 18, MD.: Lamb Engineering Co., 2125 Maryland Ave., BElmont 5-4740.
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SYRACUSE 2, N. Y.: J. W. Miller, Jr., 509 S. State St., SYracuse 3-7387.

ELLISON DRAFT GAGE CO. .Page 42
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ARLINGTON, VA.: Bill Strickler, 1027 N. Fillmore St., JAckson 7-7089.
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W. ENGLEWOOD, N. J.: Foster Equipment Co., 145 Sussex Rd. DUmont 4-0730.
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NEW YORK, N. Y.: (Home Office) 55 W. 42nd St.

GRAPHIC SYSTEMS INC. . .Page 36

GUYAN EAGLE COAL CO. . . .Page 9
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RICHMOND 19, VA.: 204 Broad-Grace Arcade 7-1961.

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BALTIMORE 18, MD.: C. D. Lutton Co., 2127 Maryland Ave., BElmont 5-5957.
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WASHINGTON 5, D. C.: Ardmore Corp., 304 Albee Bldg., 1426 G. St., N.W. MEtropolitan 8-4222.

THE HAYS CORP. . . . . .Page 39
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BOSTON 10, MASS.: Control Instruments, Inc., 55 Batterymarch St., HAncock 6-6416.
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HUNGERFORD & TERRY, INC. Page 46
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SYRACUSE 2, N. Y.: Rooms 205 & 207 O'Donnell Building, 321 Erie Blvd., W.
WASHINGTON, D. C.: 1012 14th St., NW.

JOHNSON SERVICE CO. ..Page 6, 7
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L*A WATER SOFTENER CO. .....Page 38
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LAKE CHEMICAL CO. ..Pages 40, 44
CHICAGO 12, ILL.: (Home Office) 3070 W. Carroll Ave.

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NEW HAVEN 3, CONN.: Johnson-Goodyer Inc., 45 Bristol St.
NEW YORK, 17, N. Y.: The Mercoid Corp., 205 East 42nd St.
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PITTSBURGH 22, PA.: Edward C. Smyers, 223 Ft. Pitt Blvd.
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WASHINGTON 7, D. C.: Allen-Mitchell & Co., 1053 31st St., N. W.

MONARCH ELECTRIC CORP. .....Page 46
JAMESTOWN, N. Y.: (Home Office) 118 E. First St.

NATIONAL AIROIL BURNER CO. .....Page 37
PHILADELPHIA 34, PA.: (Home Office) 1350 E. Sedgley Ave.

NEFF & FRY CO. .....Page 34
BOSTON 11, MASS.: Klein-Farris Co., Inc., 683 Atlantic Ave., HAncock 6-1210.
BUFFALO 14, N. Y.: John R. Dennis, 26 Carmel Road, ATwater 1227.
DELWARE, OHIO: G. W. Culbertson, 15 East Heffner St., 2-7652.
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SYRACUSE 5, N. Y.: Conveyor Equipment Co., 108 East Seneca Turnpike, 9-4208.

NEW YORK & NEW JERSEY LUBRICANT CO. .....Page 47
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CHARLOTTE, N. C.: J. A. Sorrells, Jr., 2335 Farmington Lane.
CLINTON, CONN.: K. Burdon, Harbor Parkway.
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PHILADELPHIA, PA.: W. E. Bierlin, Box 4910
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SKANEATELES, N. Y.: D. G. Beaman, 18 Academy Street.
SOUTH ORANGE, N. J.: T. W. Feeley, 308 Clark St.
SPARTANBURG, S. C.: R. F. Bagwell, Jr., Box 2286.

NIAGARA BLOWER CO. ....Page 28
NEW YORK 17, N. Y.: (Home Office) 405 Lexington Ave.

NORTH AMERICAN MOGUL PRODUCTS CO. .....Page 5
CLEVELAND, OHIO: (Home Office) 1370 Ontario St.

PARKER APPLIANCE CO. ...Page 10
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PHILADELPHIA PUMP DIV. OF AMERICAN METER CO. ...Page 8
PHILADELPHIA 16, PA.: (Home Office) 13500 Philmont Ave.

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BALTIMORE 28, MD.: William J. Dunn, 106 Oak Dr.
BOSTON 16, MASS.: John R. Roy Co., 419 Boylston St.
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PITTSBURGH, PA.: Edward J. Weimer, P. O. Box 7424.
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SYRACUSE 10, N. Y.: Mesdon Engineering Sales, Box 151, University Station.

PICKANDS MATHER & CO. ..Page 45
ERIE 1, PA.: 901 G. Daniel Baldwin
GREENSBORO, N.C.: Southeastern Bldg., Bldg., Phone: 22-571. Phone: 32366.
NORFOLK, VA.: 1142 Manchester Ave., MAdison 2-6233.
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RANNEY METHOD WATER SUPPLIES, INC. .....Page 31
COLUMBUS 19, OHIO: (Home Office) 841 Alton Ave.

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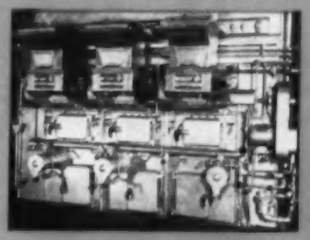

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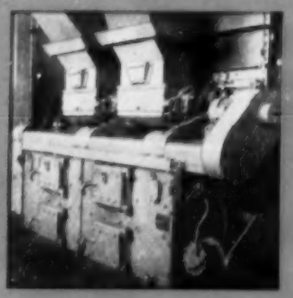

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